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RURAL SCHOOL ARCHITECTURE.

WITH ILLUSTRATIONS.

By

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LETTER.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., September 30, 1880.

SIR: A concise yet complete treatise on the proper construction, heating, and ventilation of school buildings has been a desideratum. Works of this character written in other countries have been found quite unsuitable here, and the same objection applies for the South and West to most works written in the Eastern States. The efficient ventilation of school buildings is also a matter not well understood by the majority of builders and certainly is not provided for in most buildings now erected for school purposes.

After much consideration I requested Mr. T. M. Clark, a well known architect of Boston, to undertake the preparation of an article which would be specially serviceable in the construction of school-houses in rural districts and in small villages in every part of the country, and which would include the latest and best information not only about the construction and ventilation of school buildings, but also as to their decoration. I transmit the result of his work.

Mr. Clark has applied his technical and artistic knowledge as an architect to the conditions required by the uses to which the building is to be put. His paper has been carefully revised, and will, I trust, prove satisfactory to teachers and school committees in general.

The aim in the paper is not so much to lay down rules to be inconsiderately followed as to give principles and directions suggestive of the plans best to be adopted under a variety of circumstances. It has been thought well in this connection to add in an appendix a brief selection from School-Houses and Cottages for the People of the South, by C. Thurston Chase, respecting the construction of log school-houses.

It is hoped that, at an early day, the Office may answer by a further publication some of the many inquiries in regard to buildings for high schools, academies, and colleges.

I recommend the publication of Mr. Clark's paper as a circular of information.

I have the honor to be, very respectfully, your obedient servant,

JOHN EATON,
Commissioner.

The Hon. SECRETARY OF THE INTERIOR.

Approved, and publication ordered.

A. BELL,
Acting Secretary.

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SCHOOL ARCHITECTURE.

The subjects treated of in this work will be divided as follows:
Site;
Aspect and Lighting;
Surroundings;
Arrangement;
Construction;
Ventilation;
Heating;
Sanitation;
Acoustics;
Attractiveness and Economy in Building;
Specifications and Contracts.

SITE.

It should be unnecessary to say that whatever conditions of dryness of soil, sunny exposure, or remoteness from malaria or nuisances of any kind are desirable for a dwelling house ought to be still more earnestly sought in the case of school buildings, where the most sensitive and helpless members of the community spend the greater part of their waking hours under circumstances which render them peculiarly powerless to repel noxious influences if such exist. It is well known that persons engaged in active physical employment enjoy immunity in the midst of effluvia which would seriously affect them in a quiescent state, and children in school are especially open to the attacks of noxious miasms, chills, contagions, or impure air not only from their state of physical inaction but from the concentration of their attention upon study to the neglect of their bodily sensations. As the long continuance and daily repetition of the exposure exhaust their natural powers of resistance, it is inexcusable cruelty to them to neglect the simple precautions by which at least comparative salubrity may be so easily attained.

The first essential of a suitable situation is dryness.

Presuming the lot to be an acre in area, which may be considered the standard size, no permanent moisture should be found upon its surface; nor, in malarious districts, or indeed in any, is it safe to permit the existence of depressions in which the water collects in heavy rains to retreat gradually in dry weather, leaving its muddy border exposed to the heat of the sun. Such spots are the worst possible

breeding places of malaria. They should be drained by ditches cut through them in the dry season as deep as possible, and filled with loose stones, or even brushwood, and the hollow should then be graded up considerably above the surrounding land. If there is much water or the soil is very compact, the drain should be carried, by means of pipes if convenient, to some outfall at a lower level. Grading alone, without drainage, is useless; the water collects just as before, only concealed by the loose new material. With proper drainage, the newly added earth, kept dry beneath, will gradually settle down to about three-fourths of its original bulk, and, with the help of the sod which will grow over the surface, the wet place will be permanently cured. In rocky districts, a lot situated on a side hill is very apt to be springy, and such springs are not easily stopped. Fortunately, running water in this form is comparatively harmless, and if all the hollows which hold the water are cleared out, so as to give the currents an uninterrupted descent, their vicinity may not be harmful, provided that no springs exist under the building itself and that the approaches to the school-house are so managed that no stray streamlet may cross the path in rainy weather to wet the children's feet; but such a lot is useless for a playground, and would be best avoided. In general, any dry location will be suitable, whether level or sloping. Even a very bleak and exposed spot is preferable to a sheltered one which shows signs of dampness.

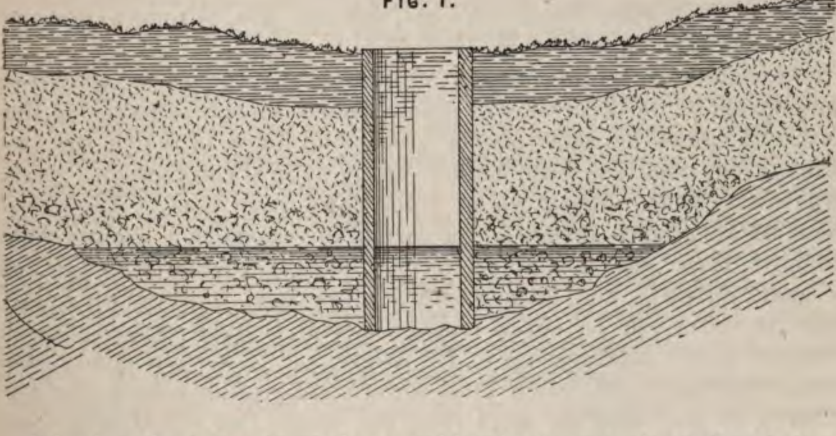
Care, however, should be taken to see that water is procurable and not too far off. In regions without public water supply a good well becomes one of the most important features of a suitable school-house lot. Every school should have one of these for its own exclusive use, near enough or rather at a suitable level with regard to the building to allow the water to be easily pumped into it. For this purpose the surface of the water in the well should not be more than 20 or 25 feet at the utmost below the first floor of the school-house, and some thought should be taken as to the relative location of house and well before either is decided finally. In many places the safest course would be to bond the land for the proposed site by a conditional agreement to purchase at a given price provided water were found of good quality and in sufficient quantity by digging a well of moderate depth in a position which should be determined upon as being most convenient to the intended building. Then the well might be and should be dug at once at the point fixed upon as most suitable in all respects for the use of the school, and if a good supply of water were obtained one prime requisite for a satisfactory house would be certain of being fulfilled; if not, the town would have spent only the cost of the trial well, which would be a very small sum, as little or no steining would be needed for this purpose.

This would be far better than buying or accepting a lot blindly, trusting to fortune to decide whether the school-house to be built upon it should possess that rare blessing, a good and convenient supply of pure

water, or be obliged to put up with a makeshift well, perhaps dry in summer, very likely situated at a distance, or, if near, probably poisoned by the oozings of the school cesspool or of the neighbors' barnyards, or by some of the corruptions which are known to contaminate the well water used in the majority of country buildings.

By careful observation of the ground, it is not difficult to locate with tolerable certainty the points where wells can be sunk with the best prospect of finding water. It should be borne in mind that the subterranean water from which wells are supplied moves through the ground in rivulets and larger streams which run along the depressions in the lower strata in the same way that the visible brooks and rivers do upon the surface, each stream draining an underground watershed of a certain extent. If a well is sunk anywhere on the line of one of these subterranean brooks, water will be found; and the first thing to be done, in selecting a spot to dig, is to determine the location of such streams as may exist below the surface of the given lot. In alluvial soils, where "hardpan" or some similar stratum of earth forms the impervious layer above which the ground water collects, the various depressions and valleys in the hardpan are generally indicated by corresponding though slight depressions in the natural surface immediately above them, and the course of these almost imperceptible surface hollows having been once traced, a well sunk on the centre line is pretty sure to reach the middle of the underground channel, and thus intercept whatever water may flow through it.

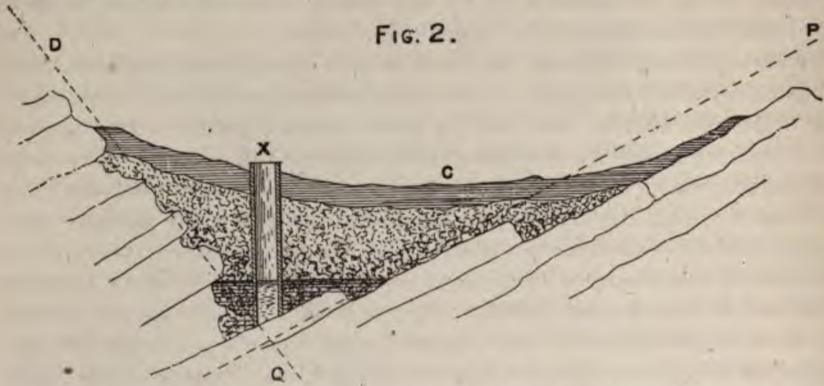
FIG. 1.



A basin, Fig. 1, on the surface would indicate a similar hollow below, forming a subterranean pool, but as one of these may not exist in a good position relatively to the proposed building, it is generally quite as well to trace the course of the smaller underground brooks until one is found which flows conveniently near, and tap it in the most suitable place. In rocky districts the course of the ground waters is more difficult to follow. The subterranean channel, or *Thalweg*, is there often not below the mid-

dle line of the corresponding depression in the surface soil, but at one side of it or the other, according to the inclination of the strata or the cleavage lines of the rocks in the locality.

FIG. 2.



Thus, in Fig 2, which shows a section of such a depression, the main channel of the water flowing over the ledge is to be found, not under C, which would be the lowest part of the natural surface, but under X, some distance toward one side. However, an approximate estimate of the probable position may generally be made by judging where a line, P Q, drawn at the edge of the valley at the angle with the horizon corresponding with the general inclination of the strata, would intersect another line, D Q, drawn from the other boundary of the valley and following the general inclination of the surface of the ledge, which is shown by the portion which crops out, and can also, to some extent, be detected from the profile of the soil above it.

In granite regions this method of ascertaining the water courses is complicated by the occurrence of seams, sometimes actual fissures in the rock, but more often small trap or greenstone dikes, in which the foreign igneous rock has been broken up by natural cleavage into small irregular crystals, among which water flows quite freely. The granite itself sometimes breaks up in certain directions in a manner very similar. These seams, however formed, usually contain water, often in great quantity, and, although they may extend to so great a depth that the water will be out of reach, it is well to trace such as may be detected in the outcroppings of the ledges, and to keep in mind those whose direction would bring them toward the position selected for the well. This may then be sunk near the seams, but not directly over them. If water is found independent of them, it is best to avoid them, for if they should be deep they might only serve to drain off beyond recovery all the water in the well as soon as the connection was made; but, if other sources fail, the excavation may be extended to them with some hope of success, especially if the vein descends from higher ground.

After the positions of the subterranean collecting pools or channels

are determined with reasonable probability, care should be taken to trace the sources from which they gather their waters. In rocky districts especially, impure water flows unchanged over the surface of the buried ledges or through their seams for long distances, and it should be positively ascertained that no barnyard, graveyard, stable, sink, drain, vault, cesspool, or other nuisance contributes anything, even during the heaviest rains, to the school-house well. If there is any suspicion of contamination, the well must be dug in another place.

The most suitable position of the well on the supposed line of the underground flow having been fixed, a trial excavation will soon show whether water exists in sufficient quantity. If the exact channel should not be struck at once, the excavation will probably show on which side it is situated, and the well may be extended toward that side. If copious springs are reached, nothing more is necessary than to dig out a shallow basin below them and then stein up the pit. If they are feeble, although probably sufficient, it is best to sink a deep excavation below them.

A better supply may perhaps be thus reached, and, if not, the pit will serve as a reservoir, increasing the capacity of the well by so much. When all is ready, the well is to be steined up with rough stone or brick; the upper two or three feet should be built with hard brick in cement, and a brick dome in cement should be built over the top, leaving a fifteen inch manhole covered by a flat stone, set in cement. A well so built will be reasonably free from drowned toads, worms, grasshoppers, and other animal , and if the suction pipe to the pump be made with the immersed end of block tin, as it should be, the danger of poisoning the children in their drinking water will be reduced within comparatively small limits.

In alluvial, sandy, or gravelly countries, the tube or driven wells have some decided advantages. They are cheap and clean, the strainer at the point and the tight iron tube effectually preventing contamination from surface water or dead animals. In case of need, several tubes can be driven and coupled together, multiplying the capacity very greatly, but a 1¼-inch tube will generally supply all the wants of a small school. These wells are patented, and a royalty of $10 is now exacted by the patentee for each well, but the device itself is simple. The tube consists of ordinary wrought iron steam or water pipe, sometimes galvanized, but more commonly enamelled either with the common black enamel or the red rubber coating of Morris, Tasker & Co., of Philadelphia. Sometimes the tin-lined iron pipe made by Tatham & Bros., 82 Beekman street, New York, is used, although it is more costly. The point is made separately and screwed to the end of the pipe before commencing operations. It is hollow, about 1½ feet long, and pierced with several hundred small holes whose united area is considerably greater than the sectional area of the tube. For most wells pipe is employed 1¼ inches in internal diameter, and points are furnished ready made of that size,

but can be made of any dimensions. A section of tube, with the point, is driven into the ground by a mallet or a machine like a small pile-driver, according to the hardness of the ground, care being taken to keep it vertical. A piece is screwed to the pipe to hammer upon, so as avoid battering the pipe. When one length is driven home another is screwed on and sunk in the same way, and so on until water is reached. Various modifications are employed for particular soils, but the principle is the same in all. When completed, the well is connected with the pump by a 1¼-inch suction pipe, either directly or with the intervention of an air chamber and check valve, if the height from the water to the pump exceeds 27 or 28 feet. The cost of such a well driven in the vicinity of the larger towns is about $2 to $2 50 a foot in average soils where water is reached at a depth of not over 20 or 25 feet, including the royalty, together with the necessary point and tubing of enamelled iron. Another kind of driven well is made by boring, after the manner of an artesian well, under Pierce's patent. In this a 6 or 8 inch hole is bored first and a 2½-inch pipe afterward put down. The cost of this kind is about the same as the tube well, and they are sometimes successful where the tube wells fail to find springs. Besides they can be bored with perfect ease through the hardest rock or masses of bowlders, where a pipe cannot be driven. The cost of rock boring, with lining tube, &c., is about $7.50 a foot. It is a peculiarity of all these wells that the supply increases after use, the flow of ground water toward the strainer opening for itself by degrees a freer passage.

The water supply once secured, the next step should be to determine the position of the building upon the ground, which cannot, or should not, be definitely done before the successful sinking of the well. In general, a spot should be chosen from which the ground slopes naturally in every direction, if such can be found sufficiently near the level of the well to make sure that the lift from the water surface to the pump in the building will not be too great. A site of this description will afford a dry basement.

Side hills are less desirable, as excavations in such situations are apt to be occupied in wet weather by temporary springs due to the flow of water from the higher land above. If, however, a sloping site is unavoidable, the springs and water courses should be carefully noted after and during some heavy rain before the excavation is commenced, and avoided as far as possible. Level ground may be bad or good according to circumstances, but if wholly or partly surrounded by higher portions it is sure to be wet.

Any moisture which may show itself under the proposed building must be cut off permanently by drains. Water flowing down a slope toward the site may best be intercepted by a semicircular trench inclosing the upper part of the building, a few feet distant from it. The trench should extend some inches below the level of the lowest part of the excavations for the building, and agricultural tile laid, or loose stones or

at the worst brushwood thrown in until it is half full. Then straw, hay, or the common eel-grass, which is the best of all, is to be placed on top in a layer 6 inches deep and the trench refilled with earth. If much water is found, the drains must be continued to some outfall, into a street gutter, for instance; if not much, the soil at the bottom and ends of the trench will probably be able to absorb it. Even when the building is raised above the ground on posts, the subsoil should be protected from dampness by cutting off at least any moisture flowing through from underground springs at a higher level. If a continuous foundation wall is intended, whether inclosing a basement or not, the soil within the inclosure should always be protected on every side from the entrance of ground water by excavating the trenches for the cellar walls 18 to 24 inches deeper than the proposed bottom of the basement and 6 to 8 inches larger all around than the walls. In clayey or damp soils, or in any soil if the building is to cover more than 2,000 superficial feet, the depth of the trench below the cellar bottom should not be less than 24 inches, and the vacant space in the trench outside of the foundation walls 8 inches, unless the stone is particularly square and well faced. If water stands in the trenches they must be graded to one corner, from which a drain pipe can be carried to some outfall. This being arranged, the trenches are to be filled to within 6 inches of the finished cellar bottom with dry pebbles, or broken stone or brick, well rammed down.

From this point the foundation walls are to be started in cement, the first or footing course of the cement wall to be a little larger than the ones above it. The foundation walls should always be laid in cement mortar throughout, and if of stone should have the best face outside and neatly pointed. The extra width of the trenches will permit this to be thoroughly done. As fast as the wall is built the extra space is to be filled up with gravel. By this means the cellar of the building will be doubly protected against dampness. Not only is the appearance of the ground water above the floor prevented by the drains beneath the walls, which collect and convey it away as fast as it rises, but the moisture, which in rainy weather trickles through the sides of the trenches and quickly penetrates walls built close against them, is intercepted by the shield of loose gravel, through which it descends, and is carried off safely by the drain beneath the footings. The smooth outer face of the wall facilitates this descent, and, there being no projections to retain water anywhere, the masonry soon dries. Where the outer side is, on the contrary, left rough, with the joints unpointed, every projecting stone and every unfilled crevice catches a part of the water which trickles down by it and conducts it to the interior, causing incurable dampness.

These few precautions, which cost almost nothing when applied at the right time, are of great importance to the future usefulness of the building. Without a dry subsoil the most careful heating and ventilation will not secure a wholesome house, while, independent of considerations of health, the larger quantity of fuel required to sustain a given tem-

perature in a place where much of the heat must be absorbed in vaporizing condensed moisture, as well as the rapid waste by deterioration of the iron and wood work exposed to a damp atmosphere, will soon show the folly of neglecting to employ all possible safeguards at the commencement of the undertaking.

Further details of construction will be found in their proper place.

Second only in importance to the requirement that the site of the building shall be well drained and dry is the consideration of proper aspect and exposure. Together with these, regard must be had to the available means of approach and the position with respect to the road. Although this last matter is of comparatively little importance, inasmuch as an intelligent arrangement of porches and a little judicious planting will give the structure a good effect, whatever may be its angle with the street, still, it should not be overlooked, and, indeed, there is no more certain way of giving picturesqueness and charm to a building than ingenuity in varying its plan from a given model to adapt it to different circumstances.

Neglecting for a moment the consideration of position with respect to the street as well as to aspect, the exposure of the building when completed and the relative force of certain winds in the given locality should be noted. Not that the arrangement or lighting of the rooms will need to be altered on account of the greater or less exposure of the building to any given winds if care is taken in the construction, but to insure that this care shall not be forgotten, as well as to take advantage of natural features of the ground for modifying the discomforts of a bleak situation, so far as may be without detriment to more important interests, it is well to devote some attention to the subject at the outset.

In our climate the winds most to be guarded against are the northwesters of February and March; and, if the building stands on the side of a hill sloping north or west or if a valley running in that direction between neighboring hills directs the current upon it, extra precautions should be taken to cover the studding of wooden buildings with inner boarding and felt paper on that side, to glaze the exposed windows with double thick glass (which is many times less pervious to cold than the single thick), and to arrange the chimneys so that the stove or furnace may be placed well over toward the coldest corner.

Trees, especially evergreens, may with great advantage be planted to break the force of the cold northwest winds and even of the southeast gales, which, though of rarer occurrence, are in some localities excessively violent. A small obstacle is sufficient to affect the force of the wind very materially. A slight elevation or even a large bowlder will shelter a considerable space on its lee side, and, indeed, a defence not too extensive is preferable to an overhanging cliff or a hill higher than the building, the vicinity of which on the side from which strong winds come is sure to cause annoyance by down draughts in the chimney.

ASPECT AND LIGHTING.

For aspect it is hardly necessary to say that a gentle inclination of the ground toward the south is especially desirable; the charm of land so situated is well fixed in the minds of most persons. Next to this the playground may slope east or west; not north, if it can be avoided.

After all these considerations have been weighed, if the school-house plot still offers a choice of several sites, all equally well fulfilling the requirements we have noted, the further selection between the different situations may be allowed to depend upon their relative position with regard to the road. While no point of healthfulness or convenience for the pupils should be sacrificed for the sake of pleasing the eyes of the loiterers in the streets, it is generally found impossible to keep a well used playground as neat and trim as a lawn, and for this reason it will be better with small buildings, other things being equal, to set the school-house between the road and the centre of the plot, reserving the portion behind it for playgrounds, while the smaller space in front may be ornamented with flowers and kept neat and attractive. The entrances should be so placed that, without altering the aspect of the school-room itself, both of them may be visible from the street. Otherwise than this, the position of the building and the direction of the street have no necessary relation to each other.

The essential consideration which should determine the orientation of the school-house proper absolutely, without reference to street lines or grades, is the lighting of the several rooms. We know that the sun rises in the east, is at its highest point in the south, and sets in the west; we know also positively the good and bad effects of different kinds and degrees of lighting and varying amounts of sunshine upon the eyesight and health of children; hence we can deduce plain rules for laying down the lines of the rooms which they are to occupy, and these rules cannot be violated in deference to a real or supposed necessity without detriment to the usefulness of the building.

It is agreed by all authorities that the most comfortable and wholesome light for the eyes is that coming from one side of the room, without interfering crosslights from windows in the opposite side or from front or rear, and it is furthermore desirable that the light should come from a group of windows, or a single one, rather than from a succession of them separated by wide piers, which cast annoying shadows.

For writing or drawing the light should come from the left, not exactly at the side, but a little in front; then neither the head, the right hand, nor the pen will cast a shadow on the paper. For reading, the light may come from either side, indifferently, but should be a little back, that it may shine brightly on the page. For any purpose, the window must not be far off, or the light will be too dim, even though it may come from the right quarter.

In arranging the more important schools, containing four or more

class rooms on a floor, only two modes of lighting are practicable: one, by windows in two adjacent sides; the other, by windows in one side only.

Of these two alternatives, the latter should always be chosen. The confusion of crosslights at right angles to each other and the shadow of the head thrown forward are injurious to the eyes and the slight advantage to be gained for ventilation by windows in the adjacent sides of a large room is not sufficient to weigh against the defectiveness of the lighting so obtained. The openings in the one illuminated side should be numerous and large, or the more distant portions of the room will be too dark, and the seats should be so arranged that the light in each room will fall upon the left side of the pupils.

Under this arrangement, with lofty rooms and large openings, the comfort of the eyes is at its highest point, and it is therefore compulsory n all German schools of every grade, and has become a common requirement in planning the better class of school buildings in this country.

For our climate, however, it may be seriously questioned whether, in small houses of one or two rooms, the value during the hot weather of the cross ventilation obtained by opening windows in two opposite walls should not compensate for the inferior quality of the lighting.

Some French schools have endeavored to meet the difficulty and combine good light with ventilation by piercing two opposite walls with windows and then concealing those on one side by permanent screens, like blinds, which allow the air to pass, but not the light.

This expedient answers for high and well lighted rooms, but there is a further difficulty in the fact that in our low studded district and ungraded schools it is impracticable to admit from a single side sufficient light to supply the needs of the scholars. The minimum approved proportion of window opening for a school room is set down at one-sixth of the floor area, most authorities demanding much more. In one of our average rooms, 30 by 40 feet, the necessary window area would thus be 200 square feet. Unless this amount of glass surface is provided, the pupils in the parts of the room farthest from the windows will suffer from insufficient light, which is far worse for the eyes than any possible cross-lights. Now, a simple calculation will show that, supposing the ceiling to be 12 feet high and the windows to extend from a line 4 feet above the floor to within a foot of the ceiling, to obtain the amount of opening demanded would require a succession of windows, say, 3½ feet each in width occupying the entire length of the longest side of the room, with piers between only 12 inches wide. It is plain that such a construction, though not impossible, is very different from anything which has ever been seen in our country school-houses; yet nothing short of this would give the remoter parts of the room even a bare sufficiency of light, and not that if any darkening by shades or blinds were permitted.

From these reasons it follows, we think necessarily, that whatever may be the best practice in large buildings, whose high stories admit

the requisite surface of glass without reducing the piers to an impracticable slenderness, and where artificial or forced ventilation keeps the air fresh without effort, small buildings of cheap construction can as a rule be neither properly lighted nor efficiently ventilated without windows in two walls, and these walls should be those on the right and left of the pupils as seated.

By this arrangement ample window space can be easily given, with allowance for partial darkening by blinds at times; the light, though less comfortable to the eyes of perhaps half of the pupils than would be that from a single direction, will be more comfortable to the remaining half, and far more so to all, teachers included, than would be the case with windows in two adjacent walls, while the advantage of being able to change the air of the room in a few moments by opening windows in opposite sides, or by the same means to maintain a current in hot weather, is in our climate of very great importance.

Adopting, therefore, the principle of lighting by opposite windows, it is necessary to consider the most advantageous aspect for these windows; in other words, presuming that the openings will be made in the longer side of the parallelogram which constitutes the plan of the main schoolroom, the proper direction of the longer axis of the room is to be determined with reference to the effect of sunshine in the room at different times of the day.

So far as the comfort of the eyes is concerned, the north light is preferable, as it is comparatively unvarying, and through windows so directed there will be no sunshine during school hours, and therefore no need of shades or blinds, which are always to be avoided if possible. But the health of children in other respects suffers very seriously from the deprivation of the sun's direct rays, so that steadiness of light must be sacrificed to the necessity for admitting them. Even the German rules recognize this, and require that while no room shall have windows on two sides only drawing class rooms shall face the north.

Next to the north aspect, the steadiest light, as well as the greatest amount of sunshine, is derived from one due south, and while a south window receives the sun nearly all day the year round, the angle at which it enters is so great that the annoyance from it in hot weather is infinitely less than from the horizontal rays which stream through an east or west window at certain times. For this reason, a south exposure is both cooler in summer and warmer in winter than an eastern or western one, and while it secures the largest possible aggregate of sunshine, a south window needs less shading with blinds or curtains than any other except one facing north.

On the whole, therefore, although some authorities hold a different opinion, the writer believes that the main room or rooms in small school buildings will be best placed with the longer axis directed due east and west, and lighted by windows in the north and south sides only.

With windows in the east and west walls, as some advise, the sun's rays will indeed traverse the room from side to side, but only at the times when their purifying and light giving quality is at its least and their power of annoyance at its highest. Such a room is unendurable in summer afternoons without much pulling down of shades and closing of shutters, processes as disturbing to the quiet of the school as they are injurious to the eyes of the scholars, at the same time that the summer breeze is shut out together with the sunlight. In winter a room so lighted is chilled on either side alternately, according as the northwest winds of March or the easterly gales strike upon the exposed surface of glass, making the room difficult to warm unless by using two furnaces, one or the other to be used, according to which side may be the cold one for the time being.

With north and south lighting all these difficulties vanish. The condition of the room in relation to the furnaces will in winter be always the same, the north side being constantly cold and the south side warm, so that a single stove or furnace placed near the north wall will at all times diffuse its heat uniformly through the room. In summer the north windows will never need shading and those on the south only to a small extent. In winter the range would be much greater, though the annoyance would at that season be far less. In any case, the shading of a small fraction of the window surface will cut off all the rays which can possibly strike upon any desk, while a west window can be effectually shaded only by closing every crevice through which a horizontal beam can pierce. The advantage in hot weather of being able to have all the apertures on both sides of the room wide open, with fractional shades, if any, on the south windows, can be best appreciated by those who have tried both systems of orientation.

Nor is the sunning of the room by south windows less effectual, but more so, than by east and west. The most obvious influence of sunshine upon the atmosphere of a room is to set it in motion, the chemical processes of deoxidation or decomposition being too obscure for our senses; but both chemical and mechanical effects are produced with greater energy by the noonday beams than by the heating, though lifeless, rays of a horizontal sun, and the circulation between the north and south sides of a room lighted from both quarters is the more active and constant by reason of the great dissimilarity in their condition, one being always shaded and cold and the other always warm.

The shape and size of the sashes is an important matter.

The height of the room will be generally about 12 feet, and if the windows are carried to within 6 inches of the ceiling the total height of the frame will be 7½ to 8½ feet. So high a sash ought not to be over 3 feet wide, and both parts should be well counterbalanced, so as to encourage their frequent opening. A heavy or badly hung sash will rarely be opened, from the simple physical inability of teacher and children to manage it. A ring should be screwed into the top of the upper sash,

and a pole and hook provided to operate it. The glass should be in rather small lights for cheapness of repairs, and double thick on all exposed sides. The English double thick is heavier than the common kind.

Shades and blinds should be avoided as far as possible. Outside blinds are generally condemned by writers on school architecture, as liable to get out of repair and difficult to manage. Moreover, they require so much wall space to fold back against as to restrict the number of windows and prevent the grouping with small piers, which gives the best light.

Inside shutters may be used where brick walls or furred projections give the necessary space for folding them back; or, better still, Venetian blinds can be easily made or obtained which pull up against the soffit of the frame by means of a cord passing through holes in the ends of each slat, and attached to the lowest one. These are made both of wood and iron. Still better, but more costly, are the rolling shutters, which coil, by means of a spring, into a box either above or below.

The cheapest device of all is the ordinary shade, which should be made of stout holland, never of paper or painted cotton, and strongly and accurately hung. This has the objection of shutting out air in summer as well as sun, and a modification may be used, consisting in a short curtain, only half the height of the window and moving up and down by means of the ordinary brass pulleys and endless cords, to which it is secured along the edges by rings and hooks.

This will be quite sufficient to intercept all unwelcome sunshine, and will still leave half the window opening free for admission of air. The securing of each edge of the cord keeps the shade stretched and in good condition indefinitely, and no rollers or springs are required. For the north windows no shade whatever will be necessary.

It is important that the sills of the windows should be as much as 4 feet above the floor. If less than this they cause a glare in the eyes of the pupils sitting near them.

The danger which some writers fear that high window sills will develop an irresistible inclination on the part of the pupils to climb up on them in order to see out may be counteracted, perhaps, by increased effort to make the school room itself attractive.

To compensate for the height of the sills above the floor, the window heads should be carried as close to the ceiling as the construction will admit. Four inches is all the distance which need generally be given in frame structures, and even in brick buildings the sash can be carried nearly as high, as will be seen further on. The illumination of the ceiling so obtained is of the greatest value, the light reflected from it being peculiarly soft and grateful to the eyes, while the proper ventilation of the room is greatly assisted by making the windows as high as possible.

Aspect must also be considered in regard to the entrances, which, in a word, should always face the south. A south entrance gives a breathing place for the children in rainy or blustering weather as they approach

or leave the building and protection to the interior from the March northwesters or easterly rain storms, which will blow in at an outside door exposed to them with such force as to make themselves felt through the whole school-room whenever the door is opened; it gives dry and clean approaches to the building after snow storms, in place of impassable drifts; and last, but not least, shelter for those too punctual scholars who are sure to arrive before the building is open in the morning.

So important has experience shown the southerly aspect for entrances to be that to this necessity is perhaps due the fashion of east and west lighting for the school room proper. The "classical" style of school planning not being able to conceive of entrances in any other position than in the gable end of a building, a south door involved necessarily east and west windows, and vice versa. Now, however, the spectre of the Greeks has ceased to reign over our architecture, and whatever ingenuity is shown in contriving south windows as well as doors will be rewarded by the applause of the elders as well as the gratitude of the children.

There may be situations where a south exposure is impracticable for one or both entrances. In such a case, much may be done by contriving porches, which, although entered from the east or west, or even from the north, can have wide windows toward the south, and angles or screens which may shelter the early arrivals from the cold winds.

SURROUNDINGS.

The choice of site and orientation of the building being thus determined, certain details of planting and laying out the school lot remain to be considered before the requirements of the school-house itself are taken up. If anything in the size of the lot or the conformation of the ground prevents ample space from being given to the rear playground, it is much better to set the building as far back as possible, and give up the whole front space to the children's games. Not only will the available area be thus made the most of, but, if the school-house is judiciously arranged, the playground will be brought on the south side of the building and thus sheltered from cold winds, while the sun reflected from the walls will add much to its cheerfulness.

However the playground may be situated, it is best left clear, without interruption by trees or shrubs. These are only in the way of the children's sports, and they soon get mangled and broken by thoughtlessness or accident; their shade is of no use in such a place, and they are liable to be used as screens to conceal doubtful actions from the eye of the teacher, whose vigilance it is well that the pupils should never be sure of escaping.

The ground should be grassed over with the closest and thickest turf possible, and base ball stations and similar places of excessive wear should be shifted every few weeks, to prevent the sod from being trodden away entirely. Wherever the natural sod is good it is best to leave it intact, as a thick sod is of very slow growth. Defective places may

be patched during the construction of the school-house with sods from the site of the building and from the paths.

If new grading makes it necessary to raise the grass from the beginning, all the loam accessible should be spread upon the surface. Two feet in depth of rich loam is not too much; the growth of the sod will be much more rapid in such a soil; and the whole should be thickly sown with red-top grass, with a little admixture of white clover.

The front space, where such an area is reserved distinct from the playground, may with advantage be treated differently by planting with trees, particularly evergreens and flowering shrubs, only taking care that no tree of any kind is allowed to stand at a less distance from the school-house than twice its own natural height when fully grown. The good effect of trees is reversed by allowing them to stand too near a building. While they may actually be used to dry up a marshy spot, by the great quantity of water which they take up through their roots and disperse by means of their leaves into the air, these same roots, near a cellar wall, will keep it damp as would the vicinity of a great wet sponge, and the shade of their branches, if allowed to fall on the school-house, not only deprives it of so much wholesome sunshine, but the moving shadows on the windows or curtains cause a flickering of the light which is distressing and injurious to the eyes.

In its proper place, however, a considerable amount of planting is permissible, with the best results. Shrubs, rather than trees, should be chosen for the most part.

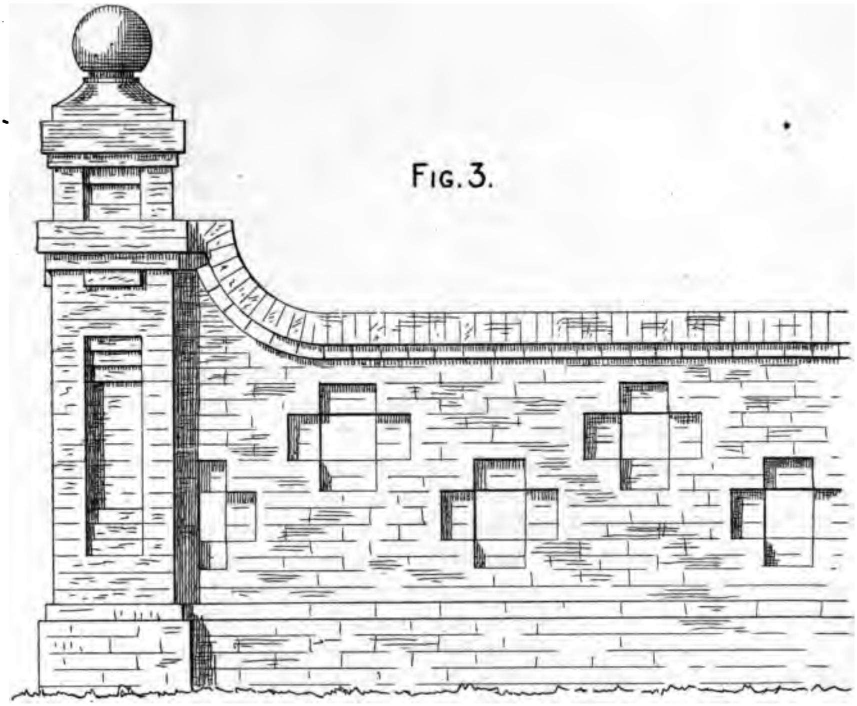
There are few portions of the United States where Missouri currant, barberry, Weigelia, cornel, laurel, lilac, roses (white, yellow, and red), viburnum or Guelder rose, California privet, Forsythia, spiræa, tartarean honeysuckle, dogwood, deutzia, holly, magnolia, catalpa, and rhododendron will not grow well in the open air on the south side of a building, and in the Southern States many more may be added.

Damp spots may be improved by covering them with clusters of the beautiful pyrus japonica, and porches may be ornamented by climbing vines, such as ivy (English, German, or the small leaved varieties), woodbine or wistaria, roses and honeysuckles; and if any one will take the trouble to sow the seeds in spring, the red and white cypress vines, the fragrant jessamine, morning glories, and the purple and white Japanese clematis may be added.

Any experienced seedsman can suggest varieties enough to keep some of the vines and shrubs constantly in bloom for nine months of the year, and a judicious selection of seeds, supplemented by slips from private gardens and young shoots transplanted from the woods, will cost almost nothing, while the civilizing influence of their beauty upon the children's minds, together with the pride and interest which their gardening operations will awaken, should not be undervalued.

It is best to plant several varieties of shrubs together in clumps. The dark evergreens or the holly and laurel then set off the brighter kinds,

and the mutual protection which they afford each other against the winds helps the growth of all, while, if one should die, it may be removed without leaving an unsightly gap, and such gardening, especially if the bushes are planted directly in the grass, is less troublesome than the cultivation and training of regularly spaced rows of bushes or beds and borders of small flowers. The clumps should vary a good deal in size and in the kinds of plants comprised in them. A large mass may be set between the front of the school-house and the street and will add much to the attractive and retired air of the building.

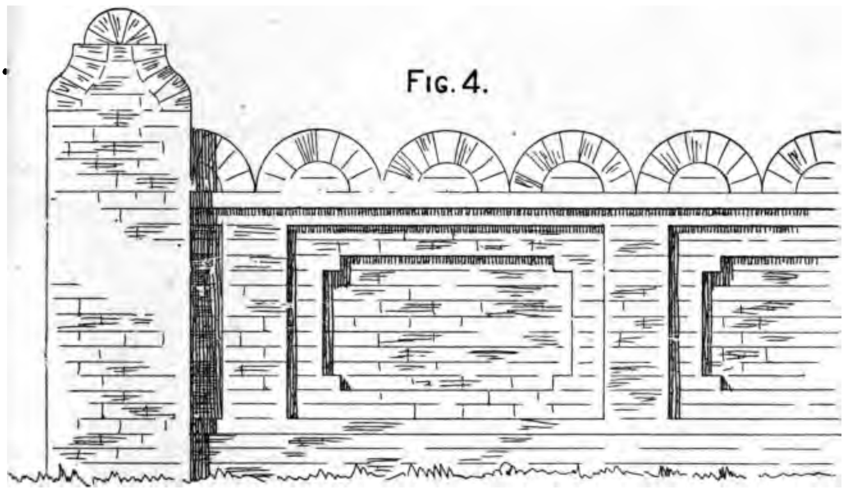


The grass in the front or ornamental ground should be fine and short, the ground neatly graded and abundance of loam placed on the top and sown with the seeds of such grasses as will form a thick and permanent sward.

The edges of the paths cannot be trusted to grow neatly with sowing only, however profusely the seed may be scattered: an edge about two feet wide must be sodded. For this, the best sods should be selected and laid on a deep bed of loam, thoroughly wet to receive them, and they should be kept moist for a few days. The walks themselves may, if gravel is not at hand, be made of coal ashes and cinders, which, though dusty at first, soon harden into a good surface. Coal tar concrete is, however, much the best material to use.

More elaborate landscape gardening will be well repaid in the general interest which a well laid out school-house lot will excite in the neighborhood, and the cost of all the work which can be applied to an acre of ground is not great. If a landscape gardener is accessible, his advice will be the best security against mistakes, but something may be done by unprofessional taste, keeping due regard to the style of the building, whether formal or picturesque. The structures of classic type, like the Grecian temples once fashionable for schools, and the Renaissance designs of some of our best modern buildings gain very much by a little terracing. This gives straight lines and smoothly sodded banks around them, and helped by a few garden vases of iron, or, better, artificial stone, which carry out, so to speak, the formality of the building into the landscape, softens the harshness of the contrast between them, and greatly increases the apparent importance of the structure.

FIG. 4.



For the fencing, a little taste will answer as well as expense. Buildings in classical style need a certain heaviness in the inclosures, and posts of masonry are most suitable. Bricks, if well burned and hard, may be laid in cement so as to form durable and handsome fence posts, especially if stone can be used for copings and for bonding the work (Figs. 3, 4, 5, 6). The intermediate portions may be of thinner walling or of open woodwork, or a construction intermediate between the two, consisting of wooden rails filled in with brickwork four inches thick (Fig. 7).

If creosoted lumber is used there is no danger of rot from the dampness of masonry.

For more picturesque buildings, the fencing may be wholly of wood (Figs. 8, 9).

FIG. 5.

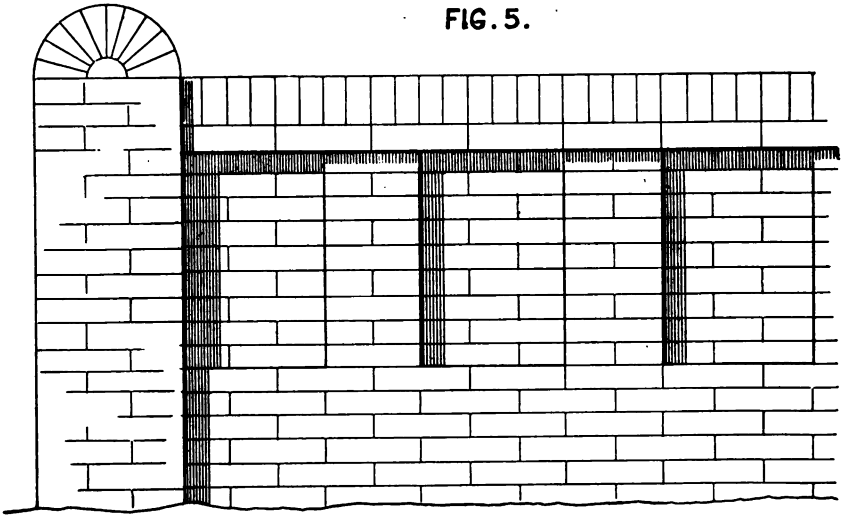


FIG. 6.

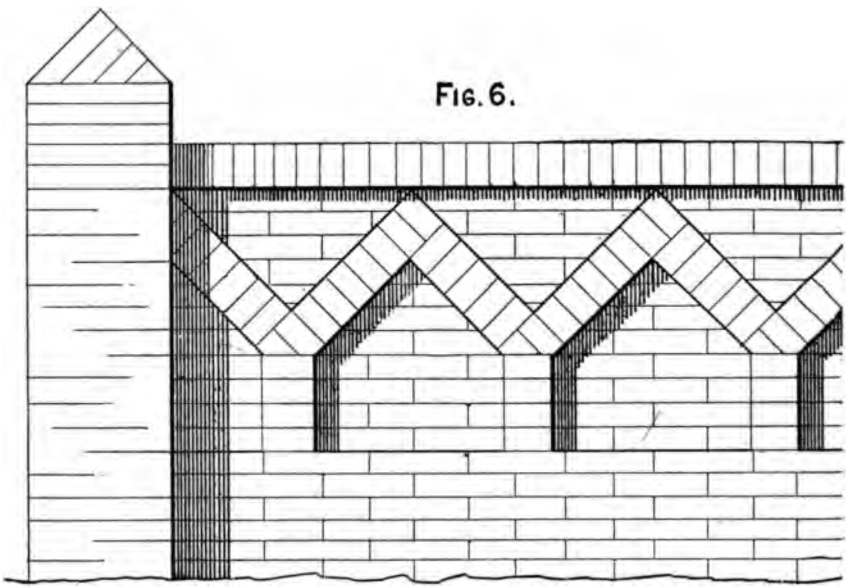


FIG. 7.

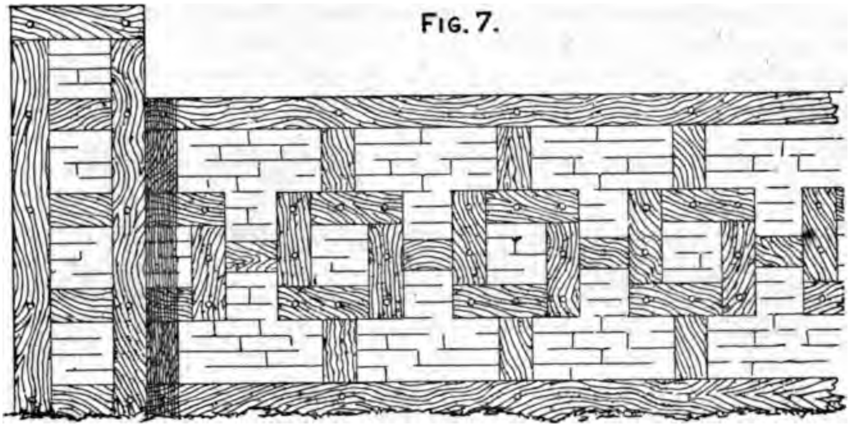


FIG. 8.

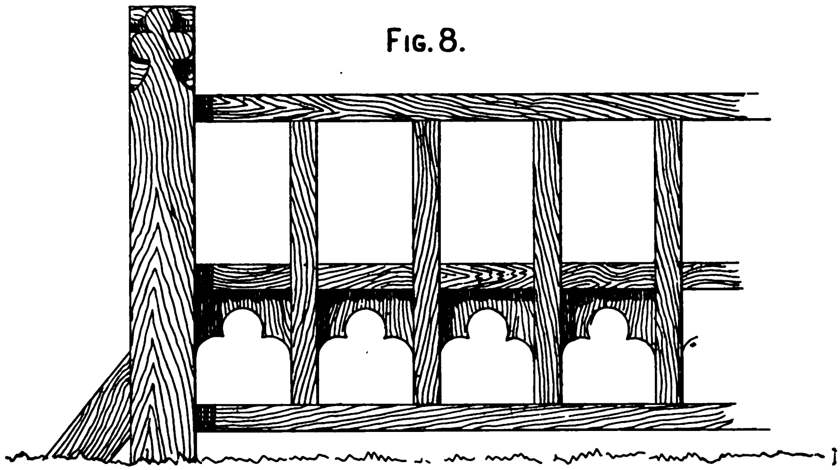
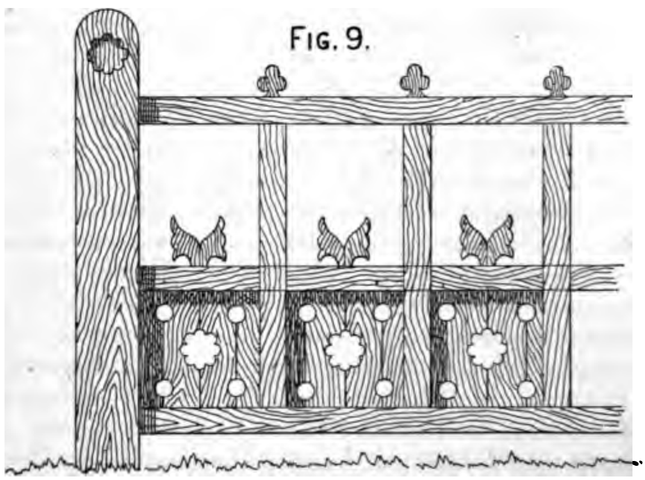


FIG. 9.



Very pretty and durable inclosures are made by landscape gardeners of red cedar or other durable poles, with the bark on, consisting of posts with top and bottom rails well secured together and the inter-

FIG. 10.

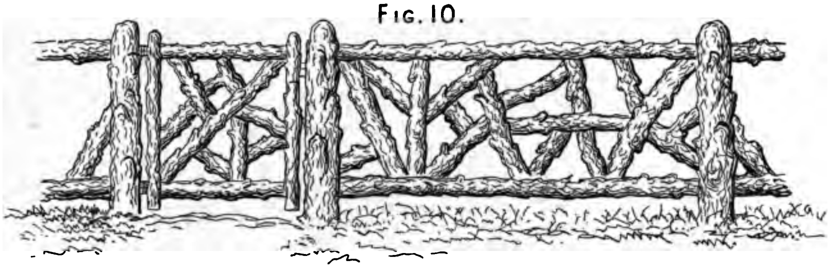
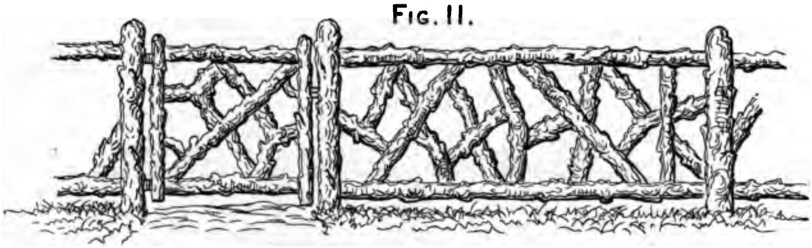


FIG. 11.



vals filled with pieces of random lengths nailed in in any direction, the only care needed being to keep the network so formed uniformly open, not thick in one part and thin in another (Figs. 10, 11).

ARRANGEMENT.

The arrangement of the school-house itself is now to be considered, keeping in view the requirements as to lighting and aspect of main room and entrances which have already been discussed and accepted as settled for all cases where imperative necessity does not overrule them. But if certain further general rules can be deduced from study of the habits and necessities of teachers and scholars, it does not follow that such rules will be universally applicable. On the contrary, there are few cases where a very considerable amount of ingenuity will not be necessary to adapt the form and arrangement of building acknowledged to be the best in theory to the different exigencies of situation, size, or cost which must to some extent govern in each particular instance; and it should be one of the recognized duties of school superintendents to see that a due degree of mental energy is expended upon the problem.

It is most unwise to delegate to the builder the task of shaping a model plan to fit a particular position. Not only will he generally lack the knowledge if not the disposition requisite for determining the dimensions of the rooms with that close regard to the number of pupils, the mode of seating, the kind and therefore the size of desks, the formation of classes and consequently the width needful for aisles, the best

mode of heating and ventilation under the given circumstances, which is necessary to success, but, even if fortified with what he supposes to be ample experience, his knowledge will very often prove to be derived from books or works which, however good in their time, have in the rapid development of modern sanitary and social science long since become obsolete.

Few persons know from actual examples how greatly the skilful planning of a school building facilitates the work carried on in it, but an idea of the possibilities of good planning may be negatively arrived at by observing the disadvantages of bad or ill considered arrangement, which may be studied in great variety in most of our country schools. Let any teacher, superintendent, or member of a committee, on visiting a school, notice for an hour or so the continual petty interruptions, annoyances, and distractions caused to pupils and teachers in ordinary school rooms by the moving about to stir up fires which have not a proper chimney draught or to pull down shades for excluding troublesome sunbeams; by the frequent rests, sometimes on the part of teacher, sometimes of scholars, to relieve the eyes from the painful glare of a front light; by the confusion and relaxation of discipline which follow the collision of classes in narrow doorways or of pupils in the tortuous and inconvenient passages among the desks, and the countless other annoyances which follow from the improper position of windows, desks, stoves, and doors, and he will realize how large is the weekly aggregate of time thus wasted.

The remedy for this is thought, the careful thought of some one thoroughly familiar with school business and ready to sacrifice all other considerations to the welfare of the school; one who can in imagination follow each scholar through his work and play, who can see before him the classes in order and sympathize with the trials and understand the duties of teachers and pupils. Such a man should sit in judgment upon every school-house plan, whether modest or pretentious, whether made by an architect or by the apprentices in the builder's shop.

In his criticism he should abandon at once all those preconceived notions of symmetry, proportion, classic elegance, or Gothic aspiration derived from books or from the vague recollection of a few examples which are apt to influence amateurs much more than architects, and devote himself solely to determining whether the heights of stories are too great for proper hearing or too small for ventilation; whether the staircases are wide enough and numerous enough for safety, and not too steep for little legs; whether the windows are sufficiently high and of suitable extent, and so placed that their light will fall where it is wanted; whether the ventilating and warming apparatus is well out of the way of the school operations, and, unless he can trust the architect's knowledge, whether it is judiciously planned in accordance with the latest practice. The dimensions of the rooms should be tested with reference to the desks to be put in them, and the width of the resulting aisles

between the desks calculated to an inch, in order that their sufficiency may be assured, while any superfluity of space may be curtailed.

This most necessary work of preliminary criticism, before plans of this kind are carried into execution, may be performed by any intelligent teacher or school superintendent, with the help of such guides and books of reference as may be procurable.

By such individual thought and criticism only can a thoroughly good mode of school planning be formed in this country, as has been done in England through similar censorship, with the imperative demand that certain requirements shall be fulfilled; and if the following notes are found applicable in suggesting and assisting such criticism, the writer believes that this work will be more serviceable than if he were to devote himself to the collection of a certain number of model plans, which, however interesting in themselves, are seldom of much service, except when interpreted by the light of well understood principles.

Taking up the component portions of the proposed buildings in the order of their importance, the main school room should be considered in a few words.

The form of this room would hardly need discussion if it were not that fantastic shapes are from time to time proposed and occasionally adopted. It is sufficient to say that the figure long proved to be best for hearing and seeing on the part of the pupils, with easy supervision on the part of the teacher, is a parallelogram, the length of which is a quarter or a third greater than the breadth. In the middle of one end is the desk of the teacher, who has his school thus before him, within reach of his voice and so disposed that he can observe every movement without turning his head or straining his eyes.

For supervision alone a long and narrow room would be most suitable, so that the whole school would be comprehended by the teacher within a comparatively small angle of vision, but sufficient width must generally be provided for drawing out classes, either in front of or behind the desks, and a compromise must be made between these two opposite requirements.

In accordance with the rules of lighting and aspect previously proposed, the room will have its longer axis directed east and west, and will be lighted by windows occupying nearly the whole length of the north and south walls.

The entrances, which must be separate for the two sexes, should be so planned that both boys and girls may be under the eye of the teacher in entering and leaving the room. They may be in the wall behind him, a very common position, but are better either in the side or opposite end walls, so that, without turning his head, his glance may follow them through the vestibules until they are out of the building. This plan will prevent the silly tricks which children carry on in the vestibules sheltered from the teacher's observation, to the amusement of their fellows but to the detriment of discipline. The best arrangement will be to

put one entrance door in the side wall, near the teacher's end of the room, and the other in the opposite end wall.

The side door may be appropriated to the boys, who will thus be nearer the teacher and more under his control in entering and departing, and the end door, which will be behind the pupils, to the girls.

The room being lighted alike on both sides, the pupils may sit facing either the east or west, but there are many advantages in arranging them to face the west. By this disposition the girls' entrance is brought on the sunniest and most sheltered part of the building, as it should be, and in interior planning the stove or furnace, which must be at the northwest corner of the room, comes in front of the pupils, where it finds the largest space and where its heat is diffused with the greatest comfort to all.

The best place for the blackboards is the end wall behind the teacher, the whole of which will be available, except what small portion may be occupied by doors to class room or teacher's room. If more space is needed, the opposite end wall may be used.

The piers beside the windows, though often fitted with blackboards, are unsuitable. The strain upon the eyes in trying to decipher marks on boards so placed, in the face of the glare of light from the windows, is very severe, and such positions, if occupied at all, should be left for coarse maps and diagrams on a large scale and in bright colors.

In the simplest cases, the large school room and its separate entrance porches or vestibules for boys and girls, with wardrobes for each and connected outbuildings, will form the whole of the structure.

More important buildings will have in addition a teacher's room and one or more recitation rooms; but these can and should be joined to the main body without interfering with the disposition, aspect, or lighting of either school room or entrances, the requirements for which are the same in houses of all the lower grades.

A good rule for vestibules is that the outside doors shall be placed at an angle with those opening from the vestibules into the school room. This will cut off the direct impulse of the wind and exclude draughts with ten times the effectiveness of outside and vestibule doors in parallel walls. They should be light and sufficiently spacious to give the crowd which pours out of the school room doors at recess a little breathing space before they are pushed into the open air.

Attached to each vestibule should be a large wardrobe. These may open directly from the school room, and should always do so where there is danger of their being robbed, but the smell of wet clothes in rainy weather, especially in poor neighborhoods, is penetrating and disagreeable, and a better disposition is to open the wardrobes from the vestibules, these being at the same time so arranged that the teacher can observe everything that goes on in either of them.

With panels of clear glass in the inner doors, these can be shut with-

out interfering with this supervision, which is useful also for other purposes.

Besides the wardrobes, each vestibule should be furnished with wash-bowls and roller towels. It is not necessary to have expensive plumbing to enable teachers and children to keep themselves as clean as they desire. All that is needful is a common cistern pump in each vestibule, with a lead or enamelled iron suction pipe to the well, and an earthenware or tinned copper basin, or sink if preferred, with a waste pipe to a dry well outside. This will cost a trifle, perhaps $50 in all, if the well is not far away. At 6 per cent. interest, this would bring the cost of keeping a school of 50 pupils clean up to 6 cents each a year.

A further investment for towels and rollers, with weekly allowance for laundry, is advisable, but not absolutely necessary.

The pumps may be had with a pin hole in the valve, so that the water cannot stand long enough in them to freeze, and traps in the waste pipe may be dispensed with as unnecessary, so that there will be no other part of the apparatus to be injured by frost.

On no account must the waste pipe empty into the privy vault. By such carelessness will not only foul gases be poured into the vestibules, wardrobes, and school room, but the admixture of water renders the contents of the vault doubly offensive and dangerous.

In towns with public water supply the arrangement will be a little different, but some means of cleanliness may always be had. If nothing better offers, the rain water of the roof can be collected and used.

In regard to certain other appliances for cleanliness and health, perhaps the most essential of all, much must depend upon circumstances. The distance between the best and the worst is so enormous that the writer can do no less than urge most earnestly that the very best apparatus should be always used where it is possible, at the same time that he considers it his duty not to overlook the very poorest and cheapest contrivances, which must sometimes of necessity be endured.

It is sometimes asserted that a school privy should never be under the same roof as the school room, and certainly it should not open into it, nor should the vault be placed where its contents can by any possibility contaminate the soil beneath the school rooms, but with proper construction and ventilation it can be brought without offense, if not under the same roof, at least within reach of sheltered and decent communication, and one improperly built and cared for should not be allowed upon a school-house plot in any case.

The advantages of placing the closets in communication with the school room are numerous. To say nothing of the dangerous exposure in winter to a delicate child in leaving a hot room and traversing perhaps the length of the playground to a miserable shed through which the wind blows freely, or of the no less injurious repression of the natural functions which the dread of such exposure occasions, the blunting of the natural modesty of children and the opportunity of corrupting themselves and

others which is afforded to the degraded ones by the shiftless, indecent, and promiscuous arrangement and condition of the ordinary school privies urgently demand that these necessary appliances should receive at least as much care as the other circumstances of school life.

How deeply children may be dragged down by their school associations is well known to experienced teachers and physicians, and even the public is sometimes startled into attention by the revelation of the condition into which such influences, joined to the horrible knowledge derived from the books which certain criminals delight to scatter among the young, may bring a school. Even young children are liable to have a bias given to their thoughts which they will bitterly regret in later years.

For these reasons all the delicate precautions with which good architects help the occupants of dwelling-houses to conceal from each other any suggestion of the degrading necessities of their common nature are tenfold more necessary in planning for school children, whose minds are far more susceptible to the influence of their material surroundings, while they have not the restraint of intimacy and affection to check prurient curiosity.

In the first place, the conveniences for the two sexes should be absolutely separated, out of sight and out of mind each from the other. They should be well ventilated, a little off the main thoroughfare, but not at the end of a long passageway, nor in any place where one must pass by a window or across a door to reach them. They should be, however secluded, in the same group as the wardrobes or woodshed, so that a person passing in that direction is not necessarily going to or from them. This seems a small matter, but it is not; it is one of the established rules of planning among architects, and especially in planning for children, whose modesty it is peculiarly necessary to consider. Yet the closets should not be far removed from the observation of the teacher, or even from supervision by the public opinion of the scholars. As the dark and filthy outhouse, scrawled with obscenity by wandering tramps, induces carelessness in children, if nothing worse, so a light and neatly finished closet, with proper provision of urinals and water tight floors, will be an object of pride even among boys, and they will readily cooperate with a teacher in keeping it clean and discountenancing the filthy habits of the rougher class. But, to remove temptation, all should be light, open, and in a sense public, each latrine to its own sex. There should be conveniences enough for all the children, dark corners should be avoided, inside as well as outside the building, and such angles as cannot be dispensed with should be overlooked by windows from some frequented place. Even clumps of shrubbery should be so arranged as not to form retreats for careless or dirty boys. This care in arrangement, so that no part of the building or grounds can escape observation, is of great value in assisting discipline, breaking up bad habits among the scholars, and encouraging manliness and modesty.

Having arranged the position of the retiring places with due regard to convenience, unobtrusiveness, cleanliness, and privacy, the kind of apparatus to be employed is next to be decided. Independent of cost, the question whether water closets, earth closets, or common privies should be used depends upon the amount of care which can be given to them. A good water closet is undoubtedly the best appliance which we have, but it involves an expense in drainage and supply which is seldom allotted to country schools, and the risk of being rendered useless by freezing is considerable, especially with the best closets. Those which are called "hoppers" can be arranged with the trap below ground, out of reach of frost, but unless by good fortune there is a large and constant supply of water these are liable to become serious nuisances. In general, it is well to remember that the stench from an inferior or dilapidated water closet is more penetrating even than that of a foul privy, and that a privy vault can be disinfected much more easily than a bad drain. In ordinary cases, the best resource is some form of earth closet, which, when properly cared for, is inodorous and is equally available in all weathers. The form of closet employed should be specially designed so that the scattering of the earth over the matter in the vault may be done by an independent mechanism from the outside. In this way the pulling of a lever or turning a crank once a day will accomplish all the requisite disinfecting, and the weekly visit of an intelligent laborer, who should make the rounds of the school-houses to fill up the reservoirs of dry earth and remove the contents of the vaults, will be all that is necessary to maintain the sanitary condition of the buildings. Further details will be found in their proper place.

If the town is unwilling or unable to do even this much for its children, the common privy vault must be accepted as a necessity. In that case, although it is both practicable and advisable to retain it in close connection with the school room, provision should be made by a short vestibule, ventilated by blind slats in the sides, or some similar arrangement, for intercepting and sweeping away the emanations of the closets before they can enter the rooms. By this precaution, with a small and tight vault ventilated as hereafter described, little or no nuisance can reach the school room.

The school room, vestibules, wardrobes, and closets will in some cases constitute the whole of the plan, but most schools will require, in addition, either a woodshed for storage of fuel or a space for cellar stairs, if the basement is used for that purpose.

As a rule, unless furnaces are set in the basement, it is both better and cheaper to store wood, and still more coal, in a shed on the ground level than under the school room floor. Some coal, especially when wet, emits sulphurous vapors in considerable quantity, and any old wood pile furnishes evidence that the fermentation of sap and the decomposition of animals give rise to vapors which are best removed from all possibility of contaminating the school room air.

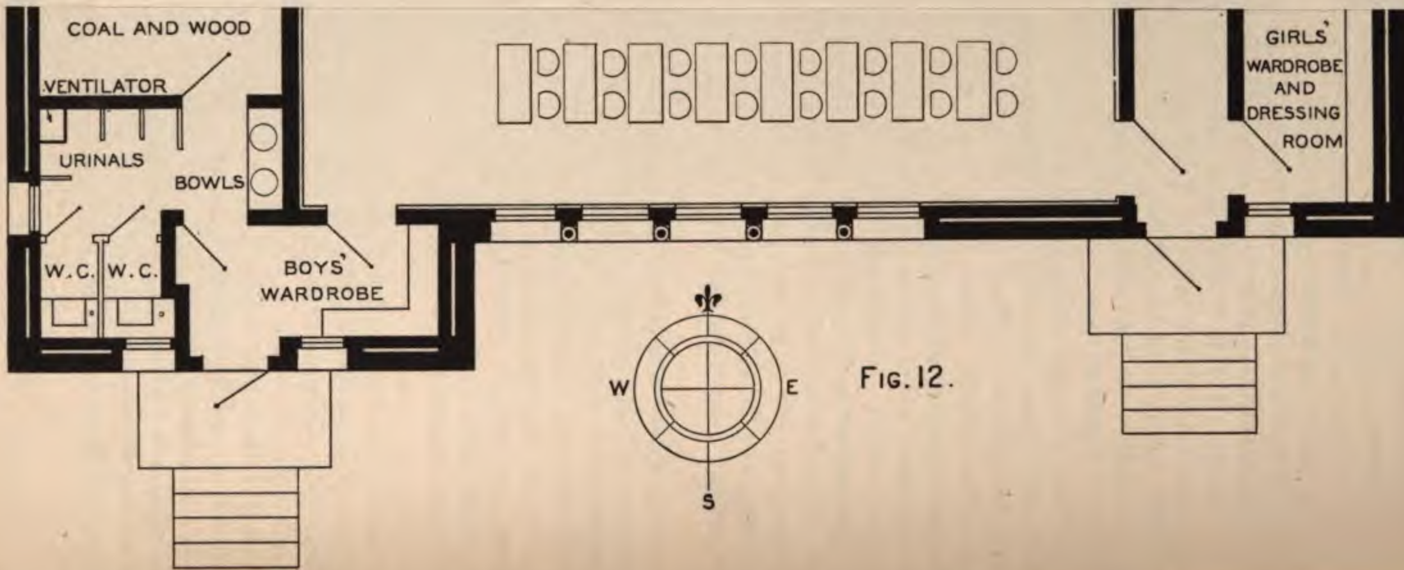

COAL AND WOOD
VENTILATOR
URINALS
BOWLS
W.C.
W.C.
BOYS'
WARDROBE
GIRLS'
WARDROBE
AND
DRESSING
ROOM
W
E
S

FIG. 12.

The woodshed may adjoin the boys' vestibule, and by placing it on the northwest corner it will serve to shield the vestibule on that side from the cold winds.

These divisions constitute the simplest form of school-house. For convenience of reference, a plan fulfilling the requirements so far noted is given here, showing (Fig. 12) the main axis of the school room directed east and west, the two porches facing the south, the girls' entrance door opening in the end wall opposite the teacher's desk, and the boys' door in the side wall beside the platform, the woodshed adjoining the boys' vestibule, with suitable arrangement of closets and wardrobes.

In the plan given, the outside steps may be covered by a gabled roof, which protects them from rain, snow, and ice, and the consequent decay, and gives the children who bring umbrellas an opportunity to get under shelter before closing them, while the gabled form prevents the snow-slides and dripping eaves common to picturesque porches.

The most desirable position for the stove being in the open space in front of the pupils and at the left of the teacher, and this being also, with the orientation here adopted, by far the most favorable position for warming the room uniformly in cold weather, it will be convenient to place the chimney in the northern part of the west wall near the stove. For an ordinary stove a flue 8 by 8 inches is large enough, but a chimney of a single flue of that size quickly bends over and finally decays, so that it must be made 8 by 12 or 8 by 16 inches, or, what is much better, a ventilating flue built in the same stack. The cost of the stack is not very much increased, and the advantage of having a ventilating flue in such a position, where the draught will be quickened by the heat of the adjoining smoke flue, is considerable. Besides, the solidity as well as the external appearance of the chimney is greatly improved by increasing its size.

The ventilating flue, if smooth inside, must be at least 20 by 20 inches; this is the smallest permissible sectional area of a warmed shaft, straight and smooth and of considerable height, for winter ventilation of a school room occupied by 48 pupils.

If a smaller flue is used, additional wooden shafts will have to be provided in other parts of the room to obtain proper movement of the air, and as the motion of the air in pipes diminishes much more rapidly than their sectional area, the cost of the wooden trunks will be found greater than that of the brickwork saved and the effect much less.

A consideration which should not be lost sight of in planning small schools is the possibility that it may become desirable to add one, two, or more recitation or class rooms and a teacher's room or library, and an arrangement of ground plan and elevations which will permit this to be done with the least alteration of the portion previously built will be very generally useful.

The plan given admits of such extension, as shown by the dotted lines.

The teacher's room and class room near the platform are well situated for use, and the position of the chimney is fixed where its flues can be used for the stoves of the new rooms and for ventilating the same. As the elevation shows (Fig. 13), the new roof can join the old without any alteration of the latter, nothing being necessary but to take off the boarding and finish from the walls next the new rooms, plaster, and cut the requisite doors.

Additional class rooms may be provided also at the opposite end in a similar manner, without interfering with any of the old doors, windows, or other parts of the construction; but, unless the building is heated by a furnace, rooms added at this end must be provided with a new chimney.

It sometimes happens that two large school rooms are required, and Figs. 14 and 15 show how the model plan may be doubled without sacrificing the better points of the arrangement. This double plan may have recitation rooms added if necessary.

In planning buildings of this class it is always necessary to keep in mind the requirements which are peculiar to the business of a small school, and to recognize the difference between them and the large structures with four rooms on a floor, where, for instance, it is the rule to place the axes of the building diagonally with the cardinal points, in order to secure sunshine in all the rooms, an object which is much better attained in the one or two roomed structure by placing it square with the cardinal points.

The dimensions and to some extent the shape of the rooms will depend upon the seating. The utmost number of pupils which should be allowed to one teacher is fixed by the best authorities at 48, and each teacher should have a separate room; but there are certain advantages in ungraded schools in having the school room large enough to accommodate a greater number. In country districts the attendance varies in character according to the season. In summer the larger children are occupied at home and the school is filled with small ones, while in winter the older boys and girls have leisure to attend but the inclemency of the weather keeps the little ones away; so that, although the average attendance may be not over 48 scholars, there should nevertheless be an extra provision of small desks for summer and of large ones for winter, increasing the number to about 60 places in all. Otherwise, in the cold season, stout children must be crammed into the infants' desks, and during the rest of the year some of the little ones will have to be seated at desks too large for them, with serious risk in both cases of causing malformation in the young and tender bodies. The additional air space gained is of value also, and, in a rapidly growing neighborhood, such a room may, in case of necessity, be temporarily utilized to its full capacity by the employment of a second teacher and the addition of recitation or teachers' rooms, if they do not already exist. The plans here given will therefore be arranged for about this number.

The exact dimensions of the main room will furthermore be dependent

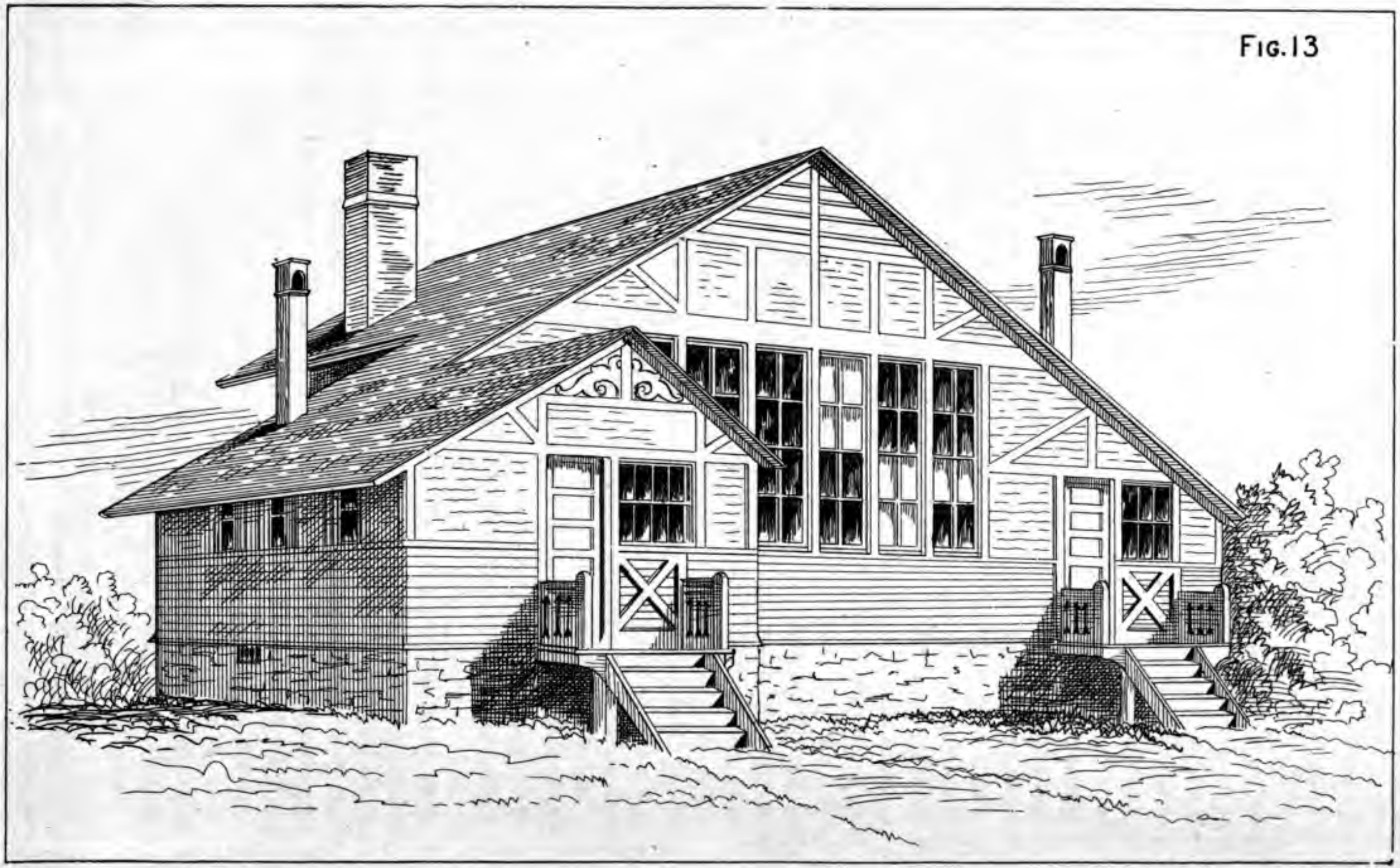


FIG. 13

on the kind of desks used. It should be unnecessary to say that the proper way to plan a building of this sort is to determine the number and size of desks and the width of aisles and platform first of all, then to construct the walls to inclose just the space desired and no more; not, as sometimes occurs, to fix upon some haphazard dimensions for the room, and when it is ready cram the desks in somehow, the result being that the room presents in one place large useless spaces and in another aisles so narrow that the children can only squeeze through them sideways.

Taking things as they are, not as they perhaps ought to be, the majority of ungraded schools are likely to use double desks, and the plan will be first laid out for such, leaving till later the arrangement to suit the single desk seating.

The dimensions of double desks vary according to the maker, and the utmost economy of floor space will be secured by determining upon the kind to be used before commencing the construction of the building.

The folding seat desks, which are desirable, especially for young children (because they allow the pupils to stand upright in their places, turn the seats back, and in that position take part in various calisthenic or other exercises), occupy a little more room from front to rear than the old kind, but are made somewhat shorter, the average length being 40 inches for the double seat, and the floor space from back to back 30 inches.

The aisles between the rows of double desks should be two feet wide.

The teacher's platform, or a space for the desk if a platform is not used, will be 5 feet wide, and 3 feet, at least, must intervene between the front of the platform and the front row of desks.

Three and a half, or, better, four feet should be allowed between the rear seats and the wall, and aisles next the side walls are necessary, 3½ feet wide if blackboards are to be placed there, or 3 feet if they are dispensed with.

There should be not more than four rows of double desks. The advantage of shortening the school room by increasing the width is more than counterbalanced by the annoyance to the teacher of constantly turning the head in trying to take in a wide angle of vision.

Three rows of desks would give a room of better form still for seeing, hearing, and economical construction, but the width of such a room, amounting to 20 feet only inside the finished walls, would not be sufficient to allow the drawing out of large classes in front or rear of the desks. With four rows, therefore, as a standard, the desks, being 40 inches long, will require 13 feet 4 inches; three 2-foot aisles between them will add 6 feet; and the two side aisles, each 3½ feet wide, 7 more; making the total width of the room, inside the finished walls, 26 feet 4 inches.

For the depth, the teacher's platform will take 5 feet; the front aisle, 3 more; eight desks, at 2½ feet each, will add 20 feet; and the rear aisle, which must be 4 feet if there is any possibility of adding recitation rooms

on that end, brings the total to 32 feet, and gives seating capacity 64 pupils of all ages.

If it is decided to use single desks, which are rapidly supersedi double ones in the more intelligent communities, the dimensions of t room will with advantage and economy be somewhat different.

The usual width for aisles between single desks is 18 inches; six ro of desks, therefore, at 2 feet each, with five aisles, at 1½ feet, will ta 19½ feet; two side aisles will, as before, add 7 feet, making 26½ feet. T accommodate 60 pupils, there will be 10 desks in each row, at 2½ feet floor space for each, which, with 8 feet in front and 4 in rear, gives 3 feet for the depth of the room.

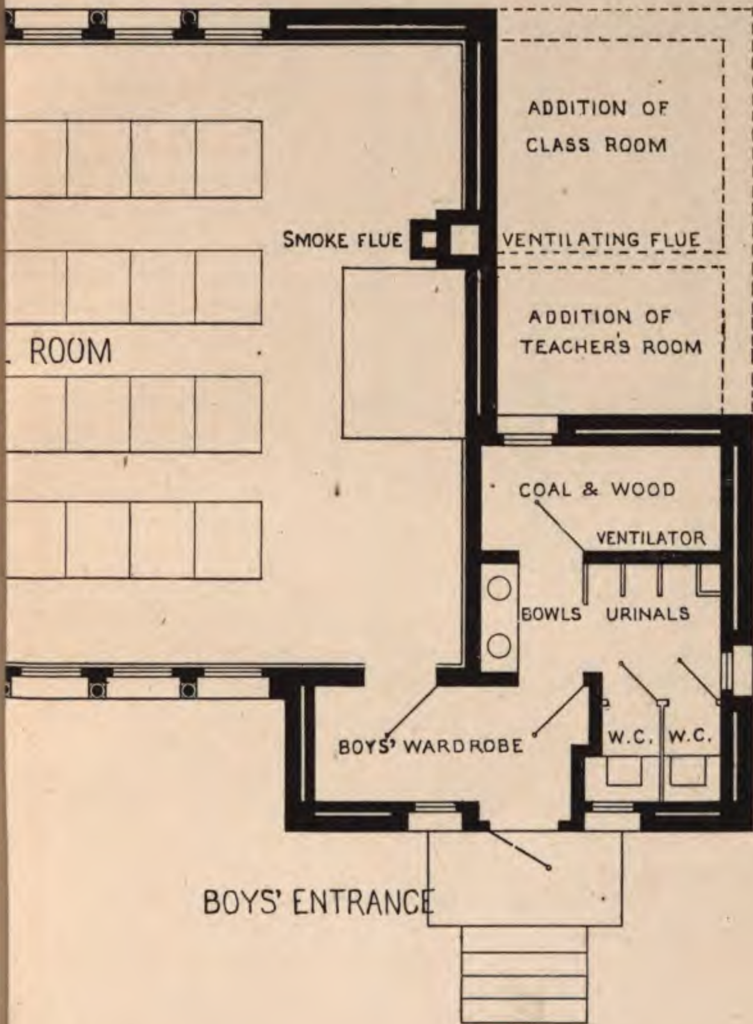
The height of the ceiling should not be less than 12 nor over 14 fee Thirteen feet is quite sufficient for any school room, and although th volume of air contained in a lofty room is larger a comparatively lo one is more easily ventilated by flues and the air more quickly change by opening the windows, and the acoustic quality of a room so nearly square as a school room must be deteriorates with great rapidity as the height of ceiling passes beyond 12 feet. Lower posts still would be admissible in small rooms for 24 to 40 pupils, if the ceiling were carried up with the roof by plastering on the rafters and collar beams, but collar beams are hardly practicable in roofs of 25 feet span.

The window sills will be 4 feet above the floor, and the heads should extend close up to the plate, which will allow about 5 inches for architrave.

A wainscoting should be carried around the room, or, at least, across the blackboard ends. Under the blackboards it should be 2 feet 4 inches high. This will be high enough to protect the dresses of the children from the chalk, and will not bring the blackboards too high for convenient use. Usually the cap of the wainscot is formed of a gutter shaped moulding to catch the chalk dust and hold crayons, but an ingenious carpenter can easily make a suitable cap by bevelling a square piece of wood inwards.

The blackboards should extend 4½ to 5 feet above the wainscot, bringing the top edge 6¾ to 7 feet above the floor. One large one should occupy the whole extent of the wall behind the teacher's platform, and a similar one the opposite end wall, while smaller ones or maps may be placed beside the groups of windows. Certain simple diagrams showing graphically the areas of different countries and their productions have been made which will be very suitable for such places. A small moulding or batten may run along the top of the blackboard as a frame.

The teacher's platform may be from 6 to 8 feet long and about 8 inches high. Some teachers prefer to dispense with it altogether, thinking that they can make their work more effective by moving about continually on a level with their scholars instead of overlooking them quietly, but such cases are exceptional.


ADDITION OF
CLASS ROOM
SMOKE FLUE
VENTILATING FLUE
ADDITION OF
TEACHER'S ROOM
ROOM
COAL & WOOD
VENTILATOR
BOWLS
URINALS
W.C.
W.C.
BOYS' WARDROBE
BOYS' ENTRANCE

The stove, if the room is to be warmed in that way, should stand in the vacant northwest corner of the room; and, if furnace heat is employed, the furnace should stand nearly under the same corner, and registers should be placed in each angle.

In this way the delivery of hot air will be equal at each register, whereas, if the furnace were set in the centre of the basement, the delivery would in cold weather be mostly on the south side of the house the greater weight of air in the northern half of the room, chilled by the impact of the cold wind, being sufficient to determine the current away from that side.

The recitation rooms may be 10 by 15 feet, or even smaller. Their furnishing will consist of benches or specially designed seats around the wall and a small desk and a chair for the teacher. Blackboards should line the walls.

For a teacher's room almost anything, even a closet, is better than no such room at all. Six feet by ten is large enough to be of great use. Book shelves, hooks for hanging clothes, or, better, a small press, and a few cupboards, with two chairs and a small table, complete its furnishing. Neither teacher's room nor recitation rooms need be so high studded as the school room.

Wardrobes may be 12 inches deep, if there is wall space enough; if not, by making them 18 inches deep hooks may be put on the inside of the doors, and room thus economized. The hooks should be triple, of malleable or wrought iron, if the cost is not too great, and screwed to strips in two rows, one row being put 6 feet or so from the floor for the large scholars, and the other not over 4 or 4½ feet for the younger ones. The hooks should be 8 inches apart in each row, and those in one row should be vertically over the middle of the space between those in the other. Ten feet in length with double strips will give 30 hooks. Each hook should be numbered and one allotted to each child. Six inches over the top row of hooks should be a shelf, and the remaining space to the ceiling may be occupied with additional shelving.

For overshoes, the lower part of the wardrobe is, in the better schools, occupied with ranges of pigeonholes 4 or 5 inches square. Five inches square, or 4 inches by 6, is not too much in country districts at the north, where rubber boots need to be accommodated, and, if the case is made of half-inch stock, a wardrobe 10 feet long will give room for 30 boxes, numbered like the hooks, in two rows, with a cupboard in addition where lunch pails may be stowed away. A little ingenuity only is needed to secure the requisite accommodation in very limited spaces.

The whole should be shut in by strong doors, which may fasten with a slip bolt, or if preferred by a lock, the key of which will be retained by the teacher during school hours. Holes bored in walls and doors will give ventilation.

If it is possible to turn a current of warm air from the furnace in

among the clothes to dry them in wet weather the health of the children will be thereby promoted.

Water closets and privies are simple in arrangement, but a few suggestions may be useful. They are in the country generally made far too large. Two feet and a half is all the width necessary or advisable, and four feet in depth is sufficient. Never, under any circumstances, should there be two seats in the same inclosure.

If a special seat for young children is necessary it should be in an inclosure by itself; but with seats made rather low, 15 inches from the floor, and the holes not too large, all children of school age will be sufficiently well accommodated. It is sometimes necessary in rough districts to prevent standing on the seats in the boys' closets. This may be done by a wide board inclined from a little above the back of the seat, forward to a point nearly over the front edge, or by a strong bar 20 to 24 inches above the seat.

The boys should always be provided with urinals, which may consist of a trough of wood or iron inclined toward the outlet and the requisite number of board partitions, 18 to 20 inches apart; but a better arrangement, because of its greater privacy, consists in stalls divided by partitions as before, but each furnished with a separate iron urinal, enamelled, if the best and most durable article is desired. Corner urinals are in some respects the best, and a large number may be set in a small space by placing them on opposite sides of a zigzag partition. Whatever kind is used, the lipped pattern should be chosen. This saves the dripping and consequent foulness inevitable with troughs, or even with urinals of the ordinary shape.

The screens should be 6 feet in height or more. In very many delicate and nervous boys nature refuses to perform its usual functions, however great the necessity, in the presence of others or under unaccustomed circumstances, and a decent privacy in the school conveniences is necessary to save such from daily pain and often more serious consequences.

The urinals may discharge into a single pipe, emptying into the vault, and all woodwork above them should be well painted and sanded. The floor under them should, if possible, be of slate, marble, or concrete, with a gutter formed in it, draining into the main waste pipe. In general as little surface as possible should be exposed to defilement, and that little should be non-absorbent, and capable of being washed clean with a few pailfuls of water.

A few details of general planning may be best inserted here, and will serve to close the subject of arrangement.

All the doors from the interior of the school room to the exterior air should open outward. This precaution, which the law makes compulsory in city school-houses, should not be neglected in the smallest buildings. It is necessary, in consequence of this arrangement, to have a landing at the top of the outside steps at least 4 feet wide, so that a child

standing on the top step when the door is suddenly thrown open from the inside may have room to draw back without falling down the steps.

Double doors are often useful in large schools, but, if used, should be not less than 5 feet in width. Other doors may be 3 feet wide, and, in general, 6 feet 8 inches to 7 feet is sufficient height. It is a common mistake to have doors too high. If ventilation is provided for independently of them, as it always should be, the larger they are the greater will be the volume of cold air admitted when they are opened and the more danger there will be that they will warp and admit dangerous draughts even when closed. Fanlights over them, however, are useful in warm weather.

Stairs and steps of all kinds should be very low and easy for children's use. Five inches in height are enough for each riser, and outside steps may have treads 12 inches wide with advantage.

CONSTRUCTION.

The proper mode of construction for school buildings is hardly less important than suitable arrangement. More, however, even than arrangement, must it depend upon circumstances of local habit, relative cost of different materials, and the absolute expense allotted for the proposed building.

Nevertheless, there are certain principles of good building which are applicable to all materials, and these should be kept constantly in mind. Perhaps the simplest mode of making suggestions will be to describe, first, a model construction, in which the best ordinary materials for their several purposes shall be indicated throughout and described as employed in the best way; then, although circumstances will probably rarely admit of the literal following of the model, there will be few cases where it will not furnish useful hints as to the proper employment of such materials as may be used, and it will be of a certain use to have the model fixed in the mind, even though it be for the time unattainable.

As often happens, the common system is far from being the best or the cheapest in the end. All the disadvantages and dangers which follow from the adoption of the light and inflammable structure of studding and boards in dwelling-houses are multiplied when the same system is applied to schools, as many terrible occurrences bear witness, and in isolated cases very successful efforts have been made at an improved construction.

From the light of these experiments and similar ones, the best practicable construction for a school building of the humblest grade would be about as follows:

The site having been carefully selected and drained as before described, the cellar may be excavated to a uniform depth of about 3 feet below the original surface of the ground. The sod, if good, should be stripped off and utilized at once in improving the remoter portions of the lot. The loam should be piled separately, to be put subsequently on top of

the grading. The gravel or earth will be disposed of as the nature of the ground may require, but on a reasonably level spot all the excavated material will generally be used in raising the ground to a gentle slope around the building; not a steep bank, but a grade of one in ten or so. The trenches for the foundation walls should be dug 2 feet below the cellar bottom and 18 inches of dry stone filled in and rammed down before starting the walls; the excavation should be made 8 inches larger than the wall, as before described, and the wall carried up with smooth outside face to the height set for the under side of the first floor. This will vary according to circumstances. If the building is to be warmed by a furnace, the height of the basement should be about 8 feet. Not only is anything less than this insufficient to give head room under the hot-air pipes, but the heating is much more certain where the basement is high enough to allow a good pitch to the hot-air pipes. If there is no furnace, 6½ feet clear will give sufficient head room, and, indeed, if the fuel is stored above ground, 3 or 4 feet under the beams may suffice. The thickness of the foundation depends upon the material and upon the thickness of the wall above. Where it can be procured, rubble stone, of granite, slate, greenstone, trap, or any of the harder rocks, makes a perfectly satisfactory foundation for a building of the kind proposed, being comparatively impervious, and therefore little liable to soak up ground moisture, to give it out again from the inner surface; while, for the same reason, the ground does not freeze to the outside in winter, gradually tearing to pieces a wall built of them, as it does a brick or soft stone foundation in cold climates. If the wall above is of rubble it will be usually 16 inches thick, and the foundation must be from 20 to 24 inches thick, according to the character of the stone, rounded bowlders demanding greater thickness than the flat pieces of slate. A hollow brick wall above will be from 12 to 16 inches thick, and a 20-inch rubble or 16-inch brick foundation will suffice. A frame building, if there is a cellar under it, should have a rubble wall 18 to 20 inches thick, according to the character of the stone, or a 12-inch brick wall will do if it is protected against the pressure of earth from outside and from the disintegrating action of frost in clayey and clinging soils by a good thick

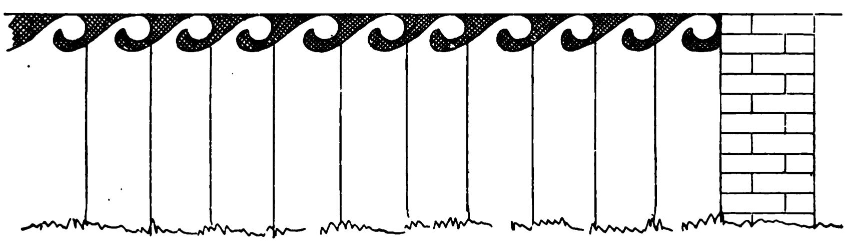


FIG. 16.

envelope of clean gravel. A solid 8-inch brick wall above will need a similar foundation. If no cellar is required, the trench wall for the foundation should still be 18 inches thick if of stone or 12 inches if of brick.

Nothing less than these will long withstand the winter frosts. In the South, frame buildings are very generally built on piers or posts, and with strong sills and good piers this is a durable and economical con-

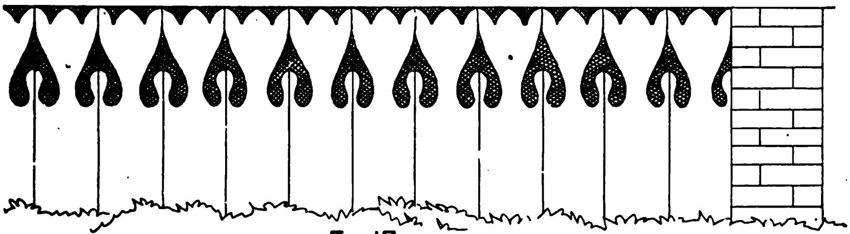


FIG. 17.

struction. It should, however, be frankly shown by raising the sills well above the ground. If earth is graded up against the sills they will

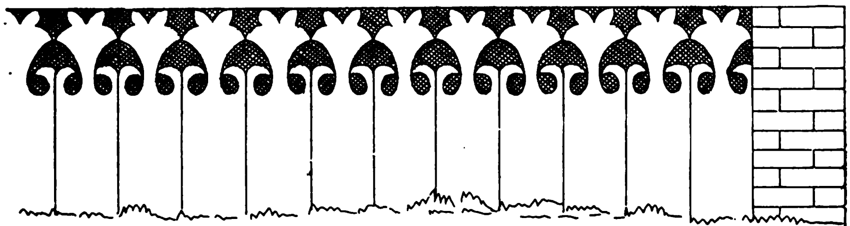


FIG. 18.

inevitably rot in a few months. The unpleasant looking hole beneath the sill may be filled with sawed sheathing, as in Figs. 16, 17, 18, 19.

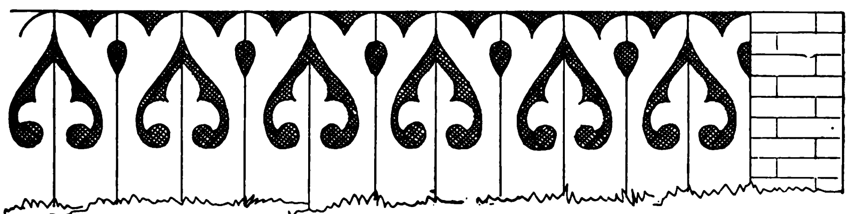


FIG. 19.

The piers should be very substantial, 18 inches square if of rubble stone or 12 by 12 if of brick. The 8 by 12 or 8 by 8 brick piers commonly used begin to bend in a few years. Wooden posts may with advantage and economy in many cases be made of spruce lumber creosoted by the Hayford process. This is done by the Hayford Wood Preserving Company, in Boston or New York, and the timbers so treated are more durable and reliable than cedar or locust. If distance renders it impracticable to obtain these, posts of red cedar or locust wood, or even white cedar and chestnut, may be used, but the best of them rot in the course of years, and the frost lifts them readily, so that such supports are generally the dearest in the end.

In iron districts refuse lengths of cast iron pipe are sometimes used

for posts with very good results. The corrosion is slow, especially if the posts are well painted and the ground does not freeze to them, so that buildings so supported are unaffected by frost. In any but the hardest soils a good sized flat stone should be set for the pipe to stand upon.

Whatever kind of basement is adopted, ample openings for ventilation should be provided. It is true that a well aired cellar, unless there is a furnace in it, makes it necessary to plaster the cellar ceiling or to lay the upper floors double, to prevent them from being intolerably cold in winter; but this is only part of the price which must be paid for a wholesome and enduring structure.

The walls above the basement will be of brick, stone, or wood, according to circumstances.

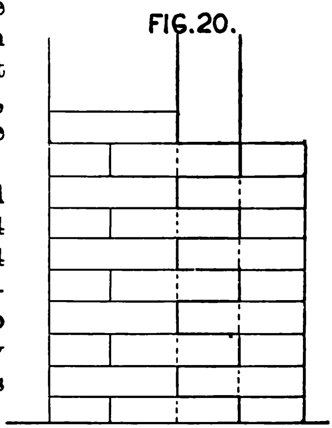
Solid brick walls of the required height may be 12 or even 8 inches thick, and must be furred with wooden strips 1 by 2 inches, nailed to the inside, and these strips lathed and plastered, the air spaces thus formed between the plastering and the inner surface of the wall being necessary to keep external dampness from penetrating into the room. Stone walls must be at least 16 inches thick, and the roughness of their inner surface rendering it impossible to nail furring strips to them independent studding must be set up inside, precisely as in the case of a frame building, and this lathed and plastered.

The concealed flues of combustible material thus formed, extending from cellar to roof, conduct sparks and flame in a few moments from any portion of the building to every other, without the possibility of discovering or arresting it in transit. Hence it is that the so called stone or brick buildings in which a fire kindled in the basement is likely at any moment to run up behind the furring and break out in the roof are in many respects more dangerous than frame structures.

Attempts have been made to make walls of masonry impervious to moisture from without by covering them with paint or cement, so as to obviate the necessity for furring, but it is found that such impervious walls condense the moisture of the room on their inner surface to an inconvenient and unwholesome extent. The only effectual remedy for these evils lies in the use of hollow walls, of brick throughout or with stone facing, as may be preferred, and such walls are by far the best to inclose school rooms.

Such a wall, of the height proposed, should be 16 inches thick, the air space being 4 inches, the outer wall 8, and lining wall 4 inches, and tied by continuous "withs" at intervals of about 2 feet. Each "with" is to be built with headers bonded alternately into the outer and inner walls. The corners should be built solid. (Fig. 20.)

FIG. 20.



The outer wall should be of the hardest bricks, the semi-vitrification of the surface being very necessary to prevent the conduction of water from the outside into the lining wall.

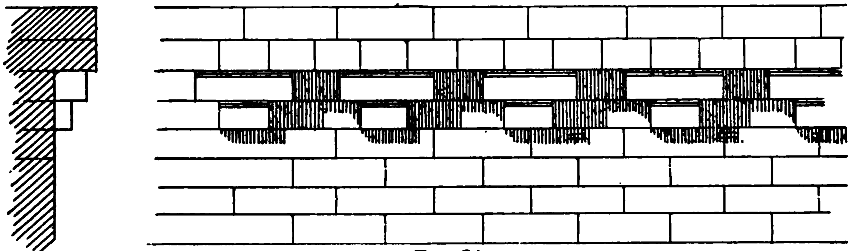


FIG. 21.

The inside of the air space should be made reasonably smooth, leaving holes at the bottom to facilitate cleaning out, and at the completion of the wall all mortar and shavings, remnants of hard-boiled eggs, bread crusts,

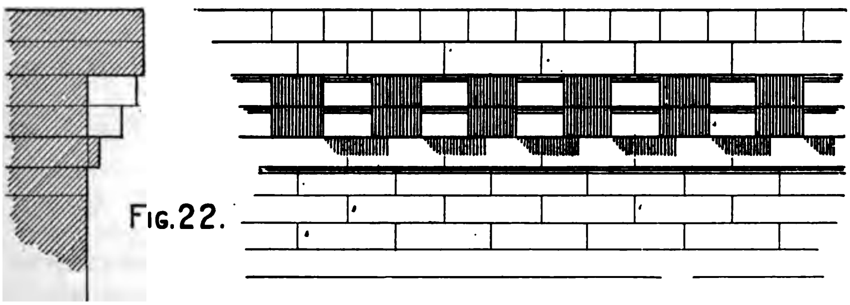
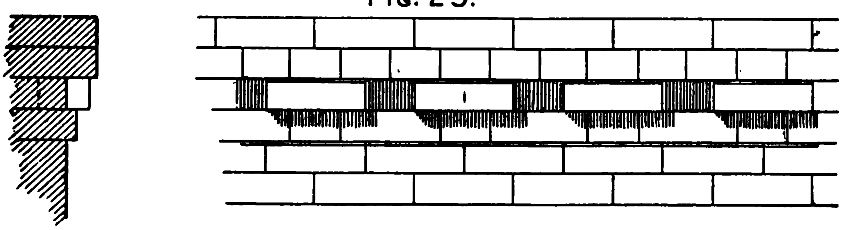


FIG. 22.

and other vestiges of the workmen's presence should be cleared out and the holes built up. At the cornice the air space will be covered over and a level bed of mortar spread for bedding the plate. A small open-

FIG. 23.



ing should be left at the bottom of each air space opening into the basement, and another at the top opening into the external air. By these a constant current of air will be maintained through the hollow. This is essential to the dryness of the wall.

It is best to build $\frac{7}{8}$ or $\frac{3}{4}$ inch iron bolts into the solid work at the corners to secure the plate. These should be 2 feet long and have a washer 2 by 4 inches or so at the bottom, and must be so set that 4 or $4\frac{1}{2}$ inches of the upper end will project above the top of the wall. This end has

a screw thread cut on it, and corresponding holes are bored in the plate, so that when this is laid on the ends of the bolts will appear above the

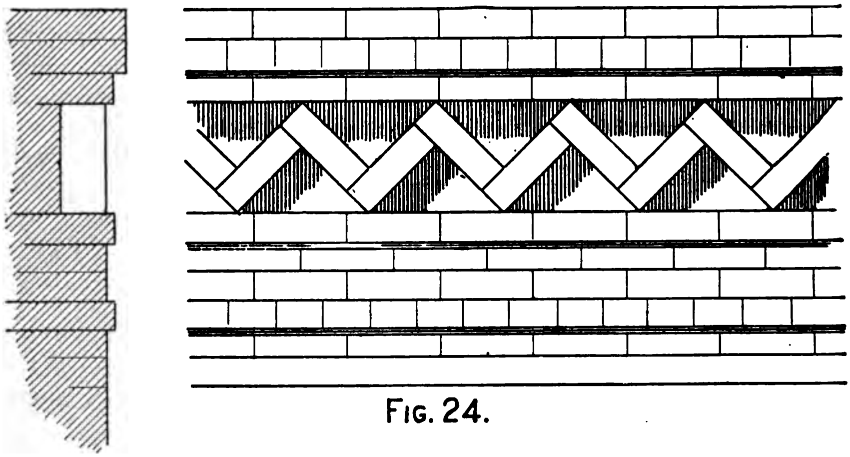
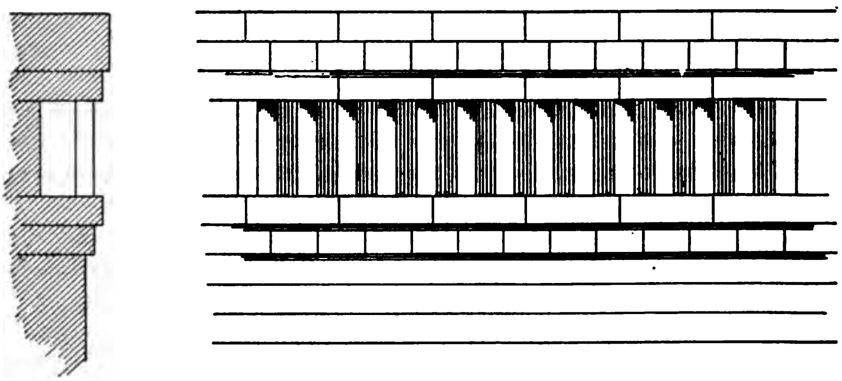


FIG. 24.

upper surface, and washers and nuts are then applied and screwed down. By this means the roof is firmly held to the walls.

Simple cornices may be formed by projecting bricks, as in Figs. 21, 22, 23, 24, 25.

FIG. 25.



In such buildings as we are considering a considerable saving of expense is made and a picturesque effect obtained outside, as well as great advantages for lighting and ventilation inside, by carrying the window openings up to the under side of the wall plate without arch or lintel, as shown in the figures below.

A cornice of brick may be made, if desired, stopping at the window openings, as in Fig. 26, but the effect will be quite as good, especially if common bricks are used, to finish the wall without any projection, and mould or cut the edge of the plate, either on the solid or by planting on mill mouldings. The former is much the better way. A boy with a

hatchet can hack the square edge of the timber into a "dog-tooth" ornament which will be sufficiently picturesque (Fig. 31).

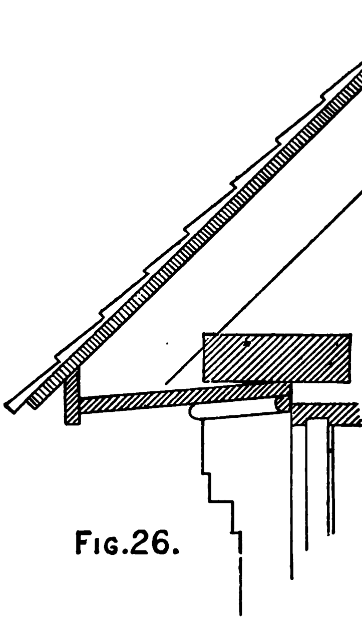
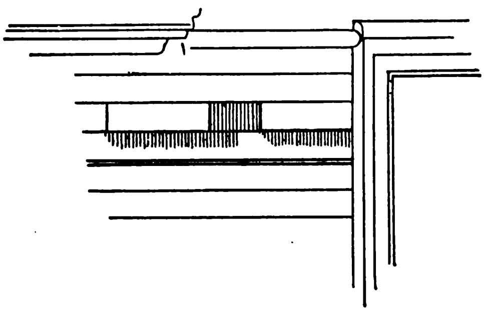


FIG. 26.

In country buildings it is quite possible with the aid of red mortar to make a good looking exterior wall of common hard bricks, instead of using face brick, the cost of which is from two to six times that of the others. The mortar is to be colored with Venetian red or any similar red ochre or mineral paint, which is added in sufficient quantity to pro-

FIG. 27.



duce the desired tint. Pounded brick, if nothing better can be had, will serve as a coloring material. The red mortar, by obscuring the joints of the brickwork, gives a smooth appearance to a wall which would look intolerably rough if laid in black or white, and the variety in tint

of common bricks gives to a wall built of them in this manner a picturesque play of color.

The bond can also be used to give a simple but pleasant decoration to the wall by means of the darker color which the headers should have.

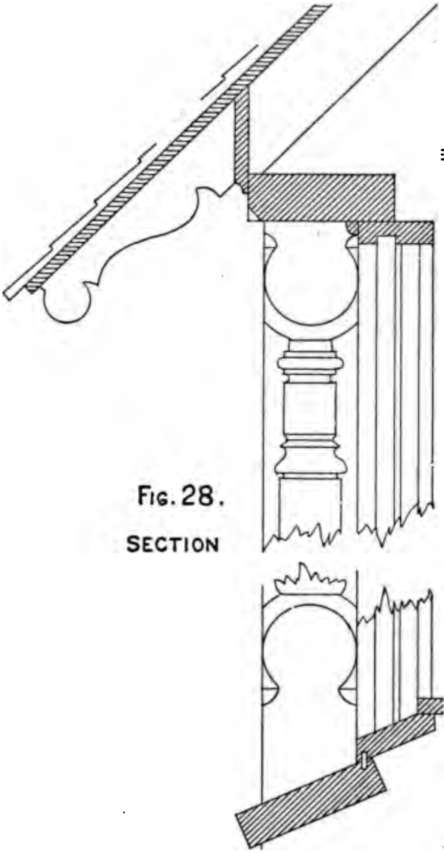


FIG. 28.
SECTION

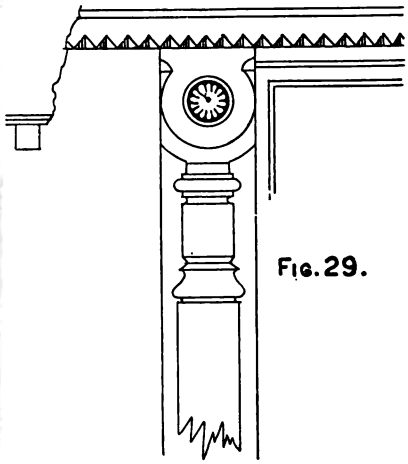


FIG. 29.

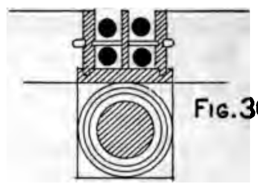


FIG. 30.

Owing to the way in which bricks lie in the kiln, the ends or heads are burned more than the sides, and as it is particularly important that the bonding bricks in one wall, which show their ends in the exterior, should be well burnt, those which possess the requisite hardness will have their heads burned to a dark red, blue, or black shade.

The ordinary bond for an 8-inch wall, which consists of a continuous row of headers every fifth or seventh course, will then give the wall the appearance of being barred with faint horizontal lines 10 or 15 inches apart. (Fig. 32.)

Flemish bond consists of alternate headers and stretchers in each course (Fig. 33), and different arrangements can be made, a variety of which may be used in the same building. (Figs. 34, 35, 36.)

The inside face of the hollow wall may be treated either by plastering

it, which may be necessary if the bricks are poor or rough, or what is better by laying the brick work of the lining wall neatly and leaving it exposed. With the cheaper kinds of face brick quite a beautiful

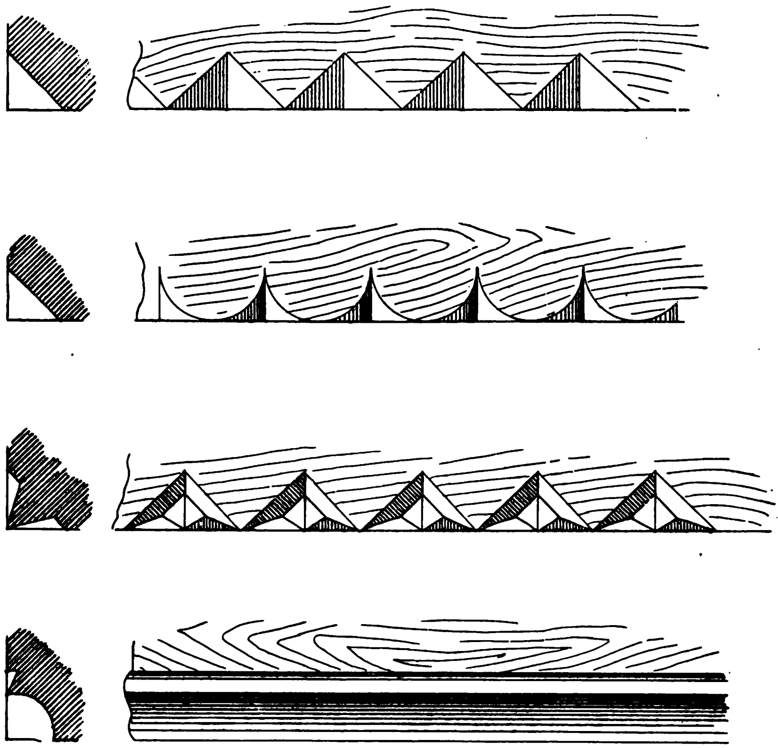
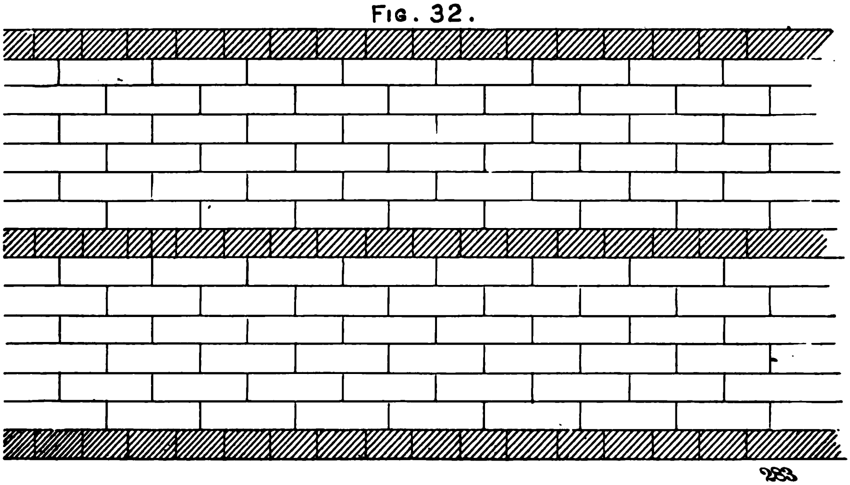


FIG. 31.

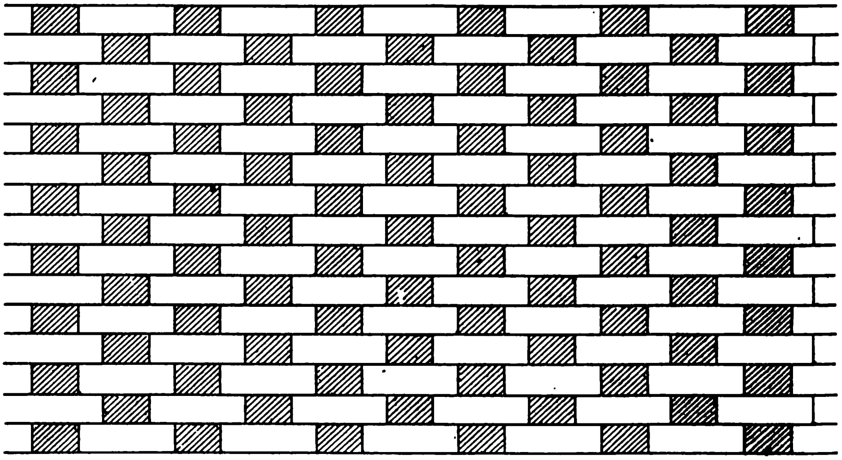
effect may be obtained, and even common hard brick, if selected with care and laid in red mortar, will make a much neater wall than might

FIG. 32.



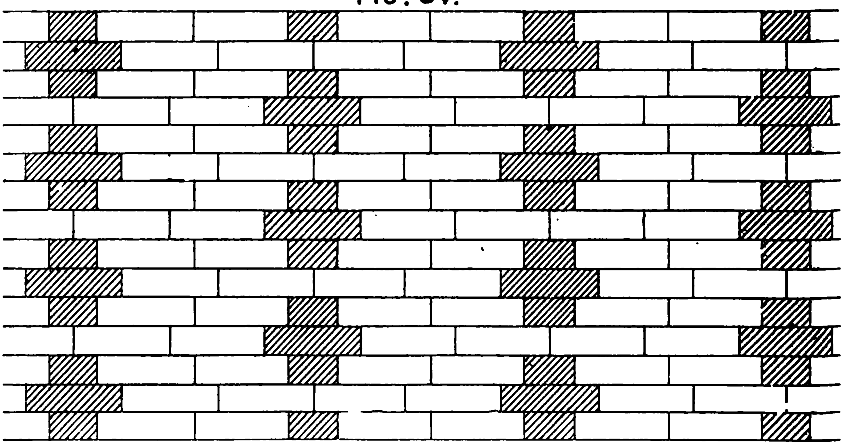
be supposed, especially if helped out with a course or two of moulded bricks near the top, to form an interior cornice. (Figs. 37, 38, 39, 40.)

FIG. 33.



A great variety of patterns of these are made and each being 8 inches long the number of any particular pattern wanted can be easily calculated. They are sent as freight, packed with hay in barrels, in any

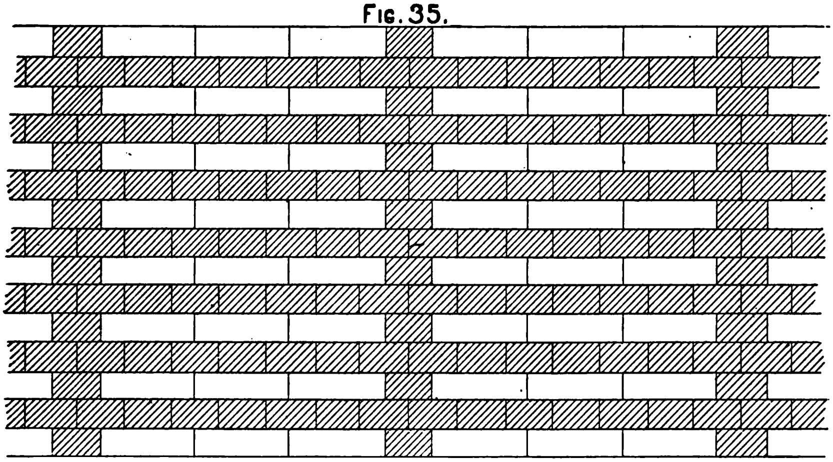
FIG. 34.



number desired, from 10 to 10,000, at 4 or 5 cents each, and form a cheap, durable, and beautiful means of decoration. They are made in Philadelphia (Peerless Brick Company), in Brooklyn, N. Y., and several other places, of red clay, and white ones are made of fire clay by Sayre & Fisher, Sayreville, N. J., and at Clark's Terra Cotta Works, Ottawa, Canada, and Glen's Falls, N. Y.

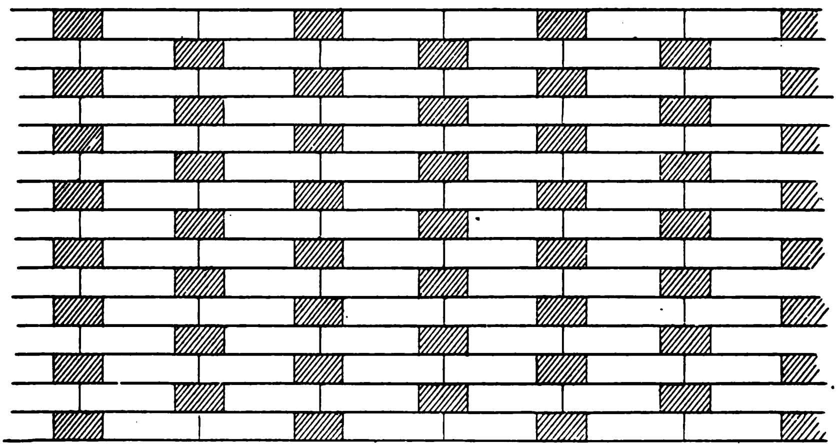
The lower part of the wall will be protected from rubbing by a wainscoting of wood.

Fig. 35.



The blackboards should properly be slabs of rubbed slate, secured with iron holdfasts to the brickwork, or the blackboard space may be plastered with cement and covered with the ordinary coating of so called

Fig. 36.



"liquid slating," which will make an infinitely better board on such a foundation than on the usual lathing covered with soft lime plaster.

Nothing can be more picturesque and pleasant in color to the eyes than such a wall, in place of the usual cracked and grimy plastering, and the bare brickwork has the important advantage of giving the freest possible circulation of air through the wall itself.

In constructing the ceiling it is desirable to avoid the ordinary light fabric of small timbers and laths, which in case of fire burns rapidly

and falls in. It is quite possible to build with little more expense a roof and ceiling which will burn slowly, if at all, and will not fall for

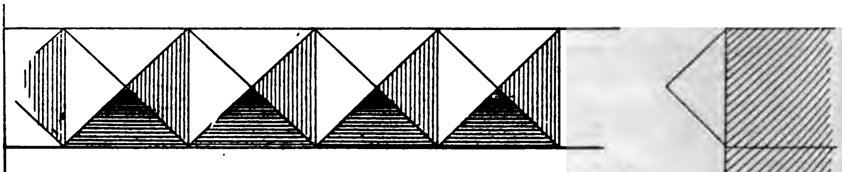


FIG. 37.

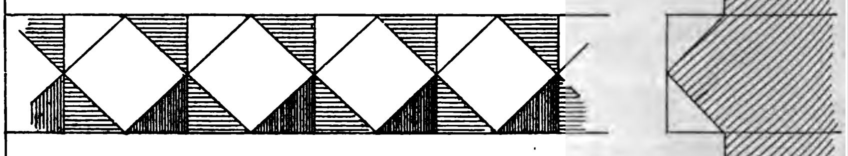


FIG. 38.

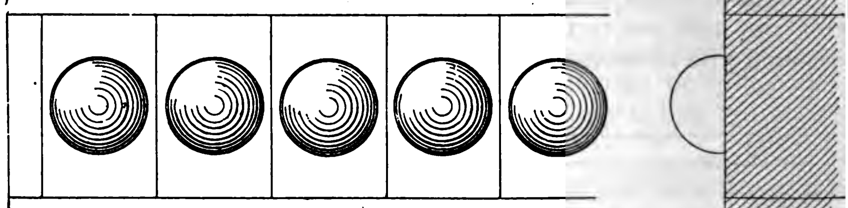


FIG. 39.

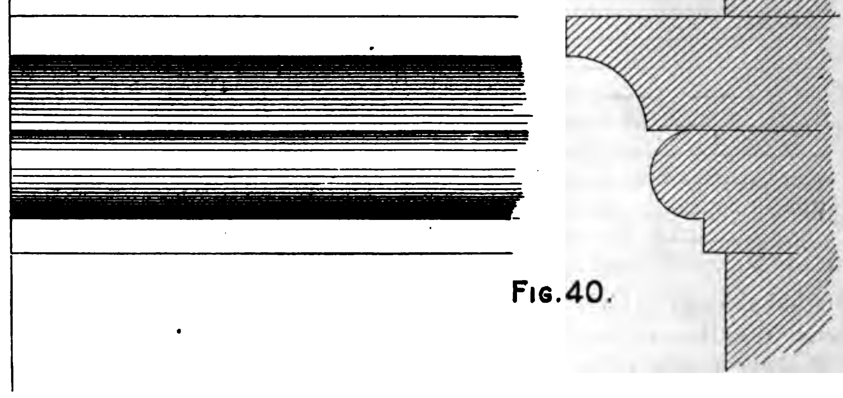


FIG. 40.

hours after they begin to blaze, giving time for the quiet removal of the pupils, their books and clothes, in place of the wild terror and confusion excited by the hay-stack-like conflagration of the usual mass of kindling wood which fills school-house attics.

The general principle to be observed is to support roof and ceiling by

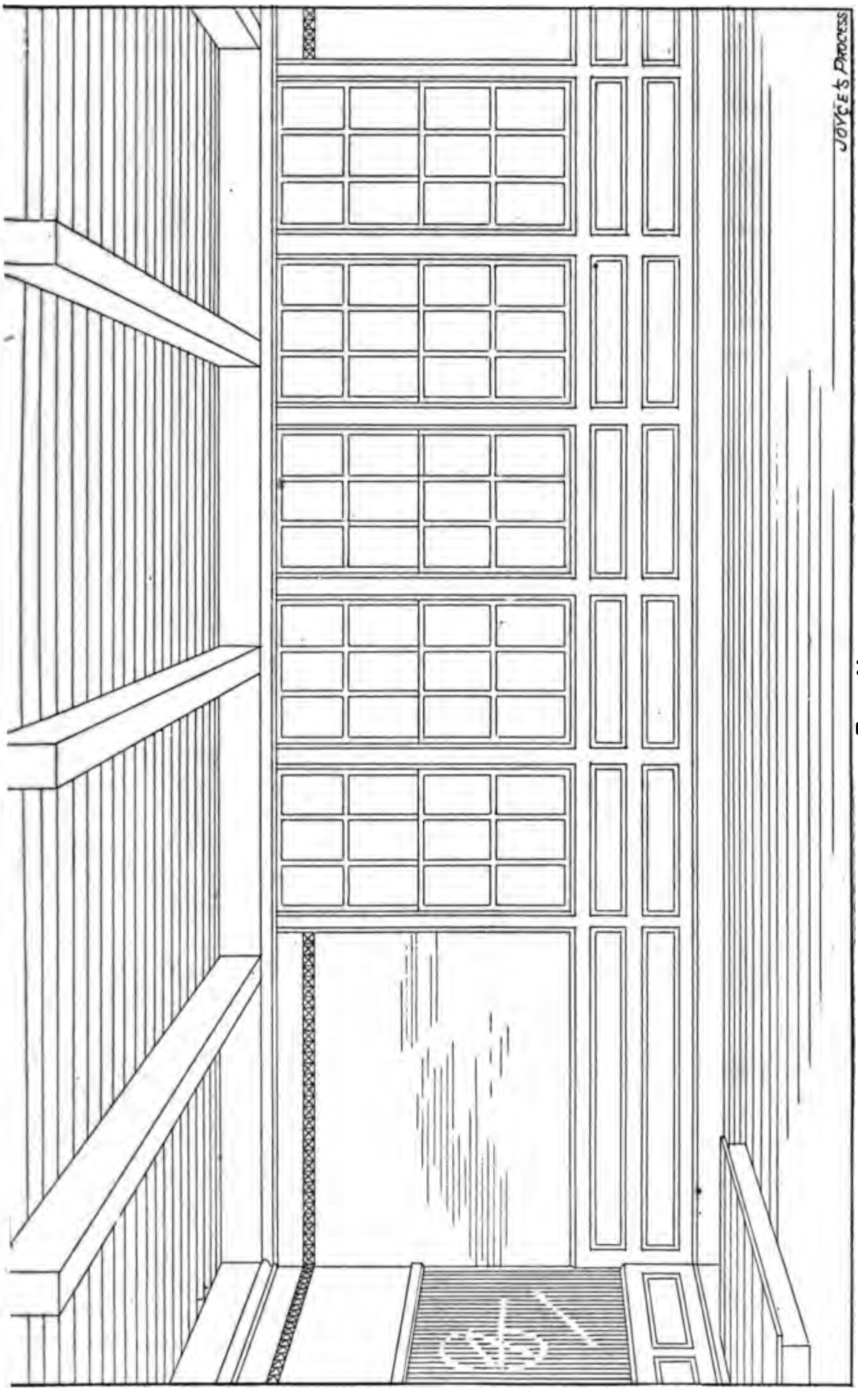


FIG. 41.

a few large timbers, rather than a multitude of small ones. This must be applied as circumstances may direct. If, for instance, instead of 2 by 6 rafters, 20 inches from centres, supporting inch boards, the rafters were made 6 by 8, 8 feet on centres, and covered with 2-inch or better 3-inch plank, the amount of stock and labor taken together in the roof would not be very greatly increased, while the latter construction would resist fire for hours after a light ordinary roof had fallen into a heap of cinders.

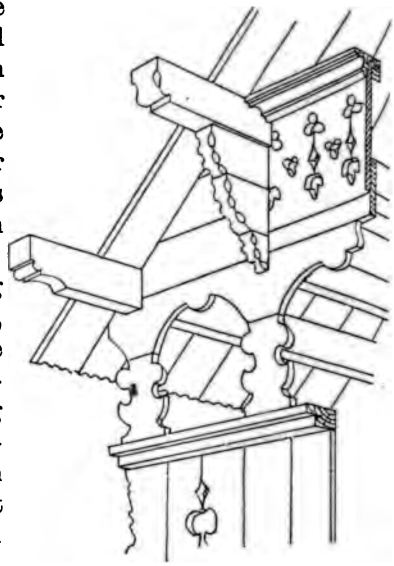


FIG. 42.

Ceilings also, instead of being hung from the rafters, should be independent, supported by thick beams crossing the room, and furred with strips underneath. If the expense of wire lathing can be incurred, a nearly fire proof ceiling can be made; if not, at least it can be made secure against falling all at once. By laying 2 or 3 inch matched planks on these large ceiling beams a still better ceiling may be made, which can be lathed and plastered beneath or even neatly finished and whitewashed or painted, while the upper side may form a flat roof. The thickness of the plank covering prevents to a great extent the heating of the room by the sun in summer and keeps out the cold in winter.

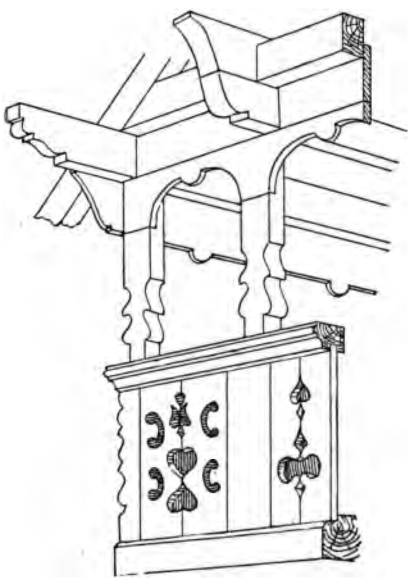


FIG. 43

Floors, if inflammable material is stored in the basement, may with advantage be similarly constructed, heavy beams, 6 or 8 feet apart, being covered with matched 3-inch plank.

Little need be said about the roofing material. There is a fashion that brick buildings should have slate roofs, but it is only fashion. Many brick and stone structures are now roofed with shingles on account of the cheapness and tightness of such roofs, which remain perfect until the shingles rot, while the repairs on an ordinary slate roof begin on the day the slaters leave it.

A slate roof is, however, often a matter of necessity, and it is worth remembering that by laying each slate in a bed of cement, spread on the upper part of the slates below, the roof is very much improved. The cement keeps the slates from rattling in the wind, the chief cause of their destruction, and is itself so protected that it can never wash out.

Metallic shingles, made in New York by the Iron-clad Manufacturing Company, form a tight and durable roof, at an expense not much greater than slate.

Flat roofs may be covered with tin, felt, tar, and gravel, felt, asphalt, and gravel, or, best of all, asphalted felt overlaid with thick slate, tile, or brick, bedded in warm asphalt. This is not much more expensive than the others, if slate or tile is accessible, and remains perfectly fire proof and water proof indefinitely. The flat roof is not objectionable in appearance, as may be judged from the sketches shown hereafter.

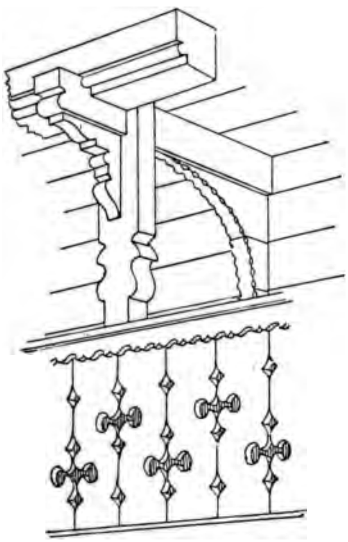


FIG. 44.

Next to a building of masonry, the most comfortable and substantial houses are those of logs. A good log wall, well chinked, is far more impervious to wind than the construction of studs and siding boards through which the winter winds whistle freely, resisted only by a layer of brown paper or imperfect "back plastering," and, rough as the log houses are commonly supposed to be, this mode of building is capable of most beautiful and picturesque forms. Figs. 42, 43, and 44 are from Swiss châlets, which are log houses pure and simple, with the sole addition of a little care in squaring the logs or planks neatly and a little fancy in cutting the ends, which are left projecting, into grotesque shapes. Many a southern or western log house is as neatly built, and only the suggestion will be needed to enable an ingenious workman to invent endless picturesque devices, which a spare day or two will suffice to carry into effect.

The Swiss carpenters fit their timbers beforehand so accurately that when brought on the ground they "come together" without the aid of nails or spikes. Even the rafters hold on the plate by simple notching, small purlins or laths are notched to them, and large shingles, or rather pieces of slabs and boards, are laid on top with considerable lap from the eaves to the top; and, to keep these down, poles are placed on them every three or four feet and heavy stones laid on the ends of the poles, the whole structure being thus often finished without a single nail.

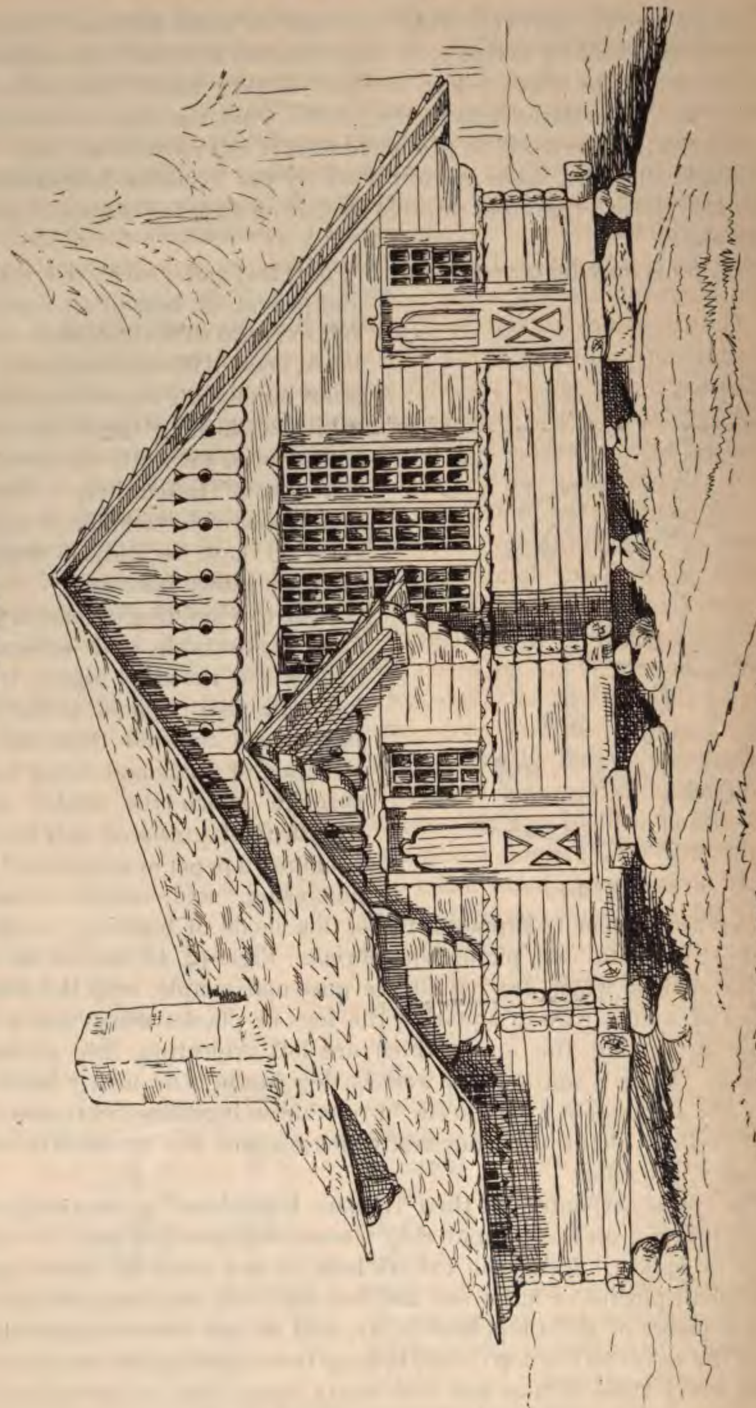


FIG. 45.

They have little wind in their valleys; probably we should be compelled to nail our shingles, but we can imitate their neatness and lively taste.

Fig. 45 gives a suggestion for a school-house in the Swiss style, which any ingenious backwoodsman could carry out.

The common timber construction of studs covered with siding boards alone, or inner boarding and clapboards and shingles, is the poorest of all apologies for building; nevertheless, it is too common to be neglected, and if children cannot be sheltered by substantial masonry or logs at least the thinly covered frame of studs may be improved by following a few suggestions.

The sill, which should be 5 by 10 or 6 by 10, must be laid in a bed of mortar, spread on top of the foundation wall to receive it, and any irregularities in the top of the wall must be filled up with stone chips and mortar. In this way only can the wind be kept out from under the floor boards. The sill should be set on edge, as the portion next the foundation will gradually rot, and the margin for decay will thus be larger.

By painting the under side of the sill with a heavy coat of cheap paint before laying, its duration will, however, be greatly prolonged, the paint repelling the dampness of the foundation wall.

The floor beams are next laid, 16 inches apart from centres. Country carpenters, to save a few inches of siding boards, often notch the sill for the beams, and cut these with a projecting tenon 2 inches deep or so, at the upper edge, so that when this is laid in the notch the top of the beams is flush with that of the sill. By this arrangement, not only do the beams hang down below the sill so as to interfere with the foundation wall, to its and their detriment, but the tenon is very liable to split off, as Fig. 46 shows, dangerously weakening the floor. A much better way is not to mortise the sill at all, but to notch the beams to within 4 inches of the top, lay them in place, and spike them through the side. The 4-inch tenon will not split off, and the mortising of the sill, a great source of rot, is avoided. (Fig. 47.)

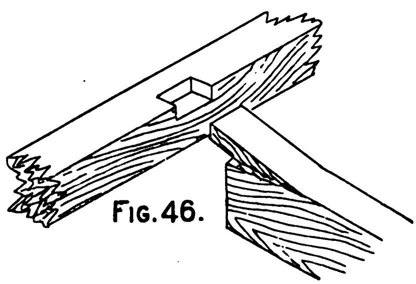


FIG. 46.

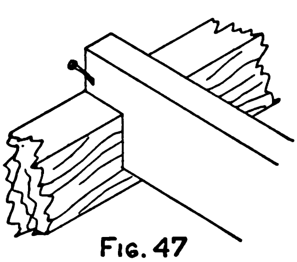


FIG. 47

If it is decided to employ the old fashioned or braced frame, as it is erroneously called (since the balloon frame admits of far better bracing), the posts will next be set up, mortised into the sill, the plate and braces, also mortised, put in place, and the tenons pinned, this skeleton being afterwards filled in with ordinary studs.

For a balloon frame all the studs are set up at once, 16 inches apart,

one being generally set beside each beam and spiked to it and to the sill without mortising. Even the corner studs are not mortised, and consist simply of two common studs nailed together.

After all are in place and held plumb by stay laths at intervals nailed diagonally to the studs and to the beams, and a few siding boards put on, the upper ends are sawed off level and the plate laid on top of the studs. Usually the plate consists of two studs, laid one above the other, the first being spiked through into the ends of the studs and the second spiked to the first.

The upright studs may be spliced by cutting the ends of the pieces square and "fishing" them with pieces of board nailed on each side.

When the siding boards and laths are on, the joint is inclosed in a box, from which it cannot escape.

By each side of doors and large windows two studs should be set and spiked together, to offer proper resistance to the slamming of the door or blinds, as well as to prevent any bending toward the unsupported side.

The bracing of a balloon frame is the most important part; without it, such a frame deserves the abuse which conservative builders heap upon it. The great object is to secure long braces, reaching from sill to plate if possible, and at an angle with the vertical of as near 45° as may be. The best way, supposing the studding to be 2 by 5 or 3 by 4 inches, is to use 2 by 4 or 2 by 5 for the braces, and gain them 2 inches into the outside of the studding, so that the whole will be flush, then spike to every stud. Such bracing is independent of shrinkage, which soon opens a little play in the angles of the old fashioned frames. Inch boards are often used for bracing, instead of 2-inch joist, but should be well nailed to be effective.

After bracing, the walls are to be inclosed. This, in the cheapest houses, is done with planed boards 8 or 10 inches wide, the lower edge of each overlapping the top of the one below.

This is very little protection against cold or wet, and in all the better class of structures an inner skin is put on of cheap boards, usually planed one side to reduce them to a uniform thickness, without which the exterior finish could not be properly put on. This should be covered with two thicknesses of felt paper, and the clapboards or shingles put on over; without paper, a sun-warped clapboard or shingle may admit wind and drifting snow.

Contrary to the common idea, a shingle covering is tighter and warmer than clapboards and much more lasting, although not so finished in appearance.

Even where neat at first, the shingles shrink after painting, showing the fresh wood between, which gives a ragged look to the surface, and the dipping or painting the edges, which will prevent this, is expensive.

The interior of the studding is lathed and plastered. In cold climates

it is usual to back-plaster by nailing fillets to the sides of the studs or on the inside of the boarding and short pieces of lath to these, then plastering, pressing the mortar up to the sides of the studs as much as possible.

All this makes a construction as inflammable as any incendiary need desire. Something may be done to lessen its dangerous qualities by lathing with wire lath instead of wood, but this is expensive. A more effectual and cheaper mode is to lay five or six courses of cheap brick and mortar on top of the sill, between the studs, filling all around full of chips and mortar, repeating the process once or twice in the height of the wall, by nailing bits of board to the studs, laying pieces of joist upon them, and building up the brickwork on these.

The best of all, however, is to fill up the spaces between the studs entirely with blocks of perforated concrete. The concrete may be made with mortar, plaster of Paris, and cinders, but it will generally be much cheaper to get it ready made, as furnished by the Fire-proof Building Company, 21 Cortlandt street, New York, or 52 Lexington street, Baltimore, or J. J. Schillinger, 111 Broadway, New York, and doubtless by other parties. It is said that the roof, walls, and floors of such a structure can be thus made practically fire proof at an additional cost of about 10 per cent. over the unprotected construction, a trifling expense compared with the great advantage gained.

Roofs of frame buildings may be shingled and painted to give a certain brightness of effect. Mineral paints are the cheapest and are generally used. Venetian red, Rocky Mountain vermilion, Iron clad paint, Prince's metallic paint, Brandon brown, and many others cost from 2 to 4 cents a pound. Indian red is the most beautiful color, but if good is considerably more expensive than the others.

A different mode of inclosing is sometimes seen, in which vertical matched boards are nailed to sill and plate and to horizontal "interties" between, and the joints covered with battens. The battens must have the edges bevelled or rounded, or they will curl up and admit water, and it is well also to hollow out the back with a plane to assist it in hugging close to the joint (Figs. 48, 49, 50). For outbuildings with-

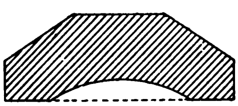


FIG. 48.

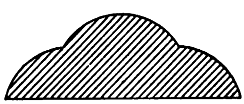


FIG. 49.

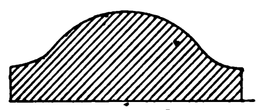


FIG. 50.

out plastering, where the studs can be 3 or 4 feet apart, this mode is economical, but in places where the studs must be set close for nailing laths it is neither weather tight nor cheap.

Interior finish is in such buildings not a complex matter. Upper floors should if possible be of Georgia pine, in narrow, matched strips, 4 inches wide or less, and well soaked with hot linseed oil when first

laid. This, if the applications are repeated until the wood refuses to imbibe more, will give a hard, polished, impervious surface, which can be easily washed and does not become filled with dirt like an ordinary floor.

Wainscoting and door and window trimmings are best of hard wood. Ash is generally used, being common and cheap. Chestnut is coarse in grain and soon gets a dirty look. White wood (basswood or tulip-wood) is still cheaper, and, though not very hard, does tolerably well; it darkens very much with age, and should have the nail holes concealed as much as possible, otherwise the putty used to fill them up at first will, as the wood darkens, appear conspicuously light. Maple may be used if not too expensive. It is the best of all woods for floors, being particularly close grained. Butternut and black walnut are handsome but costly. All these woods need to be finished by the painter.

The simplest application is a coat of linseed oil, to bring out the grain, followed by one, two, or three coats of shellac varnish. This should be allowed to harden and then be rubbed down with fine emery cloth dipped in linseed oil. Oiling alone is sometimes thought sufficient, but, the pores not being filled, the wood gets black by handling. The pores of ash, chestnut, or black walnut are so large that shellac alone will not fill them, and they must first be rubbed over with a paste of oil, turpentine, and whiting or wax, or with "patent filler," so that the varnish may cover them smoothly.

Oak alone, of all woods, may be used without filling or painter's work of any kind, its naturally hard, glossy grain needing no help from varnishes. It must be carefully seasoned and used with understanding of its qualities, but so employed is one of the best finishing materials.

Soft woods must sometimes be used for finish, and may with advantage be oiled and varnished with shellac, like the hard woods. This will keep them from showing finger marks, as is inevitable where the wood-work is painted. After rubbing down, pine or spruce should have a light coat of shellac for a completing operation, to give a slight gloss.

Doors must be of soft wood, and such finishing will be very appropriate for them, where the standing finish is of harder material. In the more elaborate buildings, the pine doors are veneered with hard wood to match the other finish, but this adds to the expense. To make a solid hard wood door which will not warp is possible, but very difficult.

Wainscoting should be panelled. If made only 2 feet high, which is the proper height at the ends of the room where blackboards are to be set above it, with panels 12 inches high and 4 to 8 feet long, the cost will be very little greater than that of vertical matched sheathing and the effect in every way better. The joints of sheathing shrink unequally, even when half of them are not mere imitations, and the work begins to look ragged and cheap almost as soon as finished, while the seams afford harbor for insects. Under the windows the wainscot will look best to be the whole height from floor to window sill, 4 feet, but this may be

managed with two long panels, one above another, helped out by a bevelled baseboard. (Figs. 51, 52.) For very cheap work the panels may

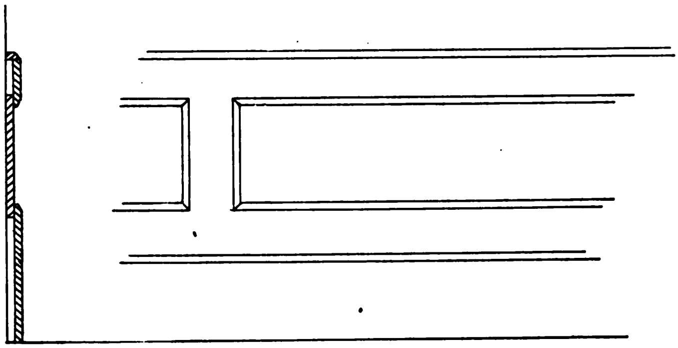


FIG. 51.

be ⅜-inch boards nailed to the wall, and the framing or "stiles," also of ⅜-inch pieces, neatly fitted and nailed on top. This is hardly to be

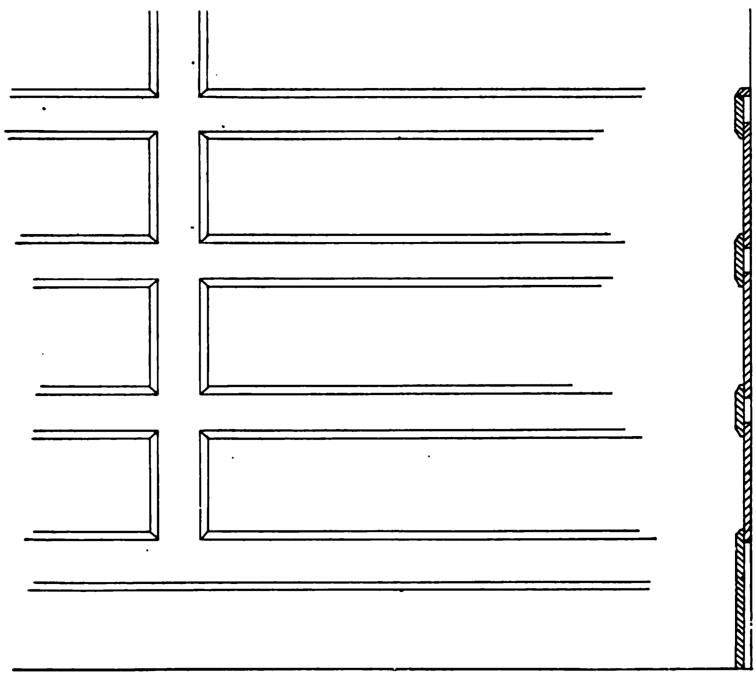


FIG. 52.

recommended, but it is better than matched sheathing. With hollow walls, when plastered on the brickwork or with the lining wall furred, ¾-inch strips, or grounds, are nailed on before plastering, by driving the nails into the joints of the masonry, and the finish is nailed to these.

Where the lining wall is exposed, grounds may be used, but it is better to fit the woodwork close against the brick, driving the nails into the mortar joints directly or into wedges of wood previously forced into the joints. In any case where woodwork is to be set against masonry, whether plastered or not, it is of very great advantage to give it a thick coat of paint on the back before putting it up.

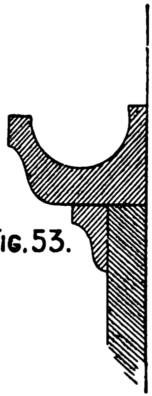


FIG. 53.

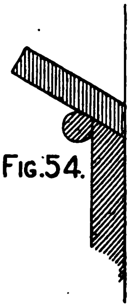


FIG. 54.

Wainscoting should be finished with a bevel or quarter round, which on the side walls may form a continuation of the stoolcap moulding of the windows. Under the blackboards it is common to finish with a moulding either shaped out of the solid into a trough on the top or supporting a separate one, which may be simply a strip of half-inch board, inclined toward the blackboard. This is to catch chalk dust and hold crayons and rubbers. (Figs. 53, 54.)

Hallways and vestibules may with advantage also be wainscoted in the same simple manner, 3 or 4 feet high.

Door and window architraves are best very simple. Nothing is better or neater in effect than a $\frac{7}{8}$ inch board, 4 or $4\frac{1}{2}$ inches wide, bevelled on each edge. The bevel may mitre around the top of wainscot.

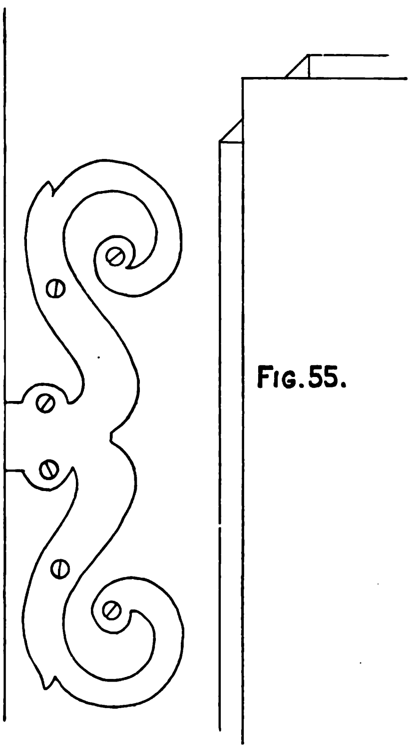


FIG. 55.

When the finish comes against the irregular surface of brickwork, instead of scribing the wood to the outline of the brick, trouble may be saved by putting the wood on with straight back and filling the interstice with plaster of Paris, colored to match the bricks.

The best blackboards, and the cheapest in the end, are of slate. These can be had of any slate dealer, three-quarters inch thick, with smooth rubbed surface, for 30 or 35 cents a square foot. Such boards make little dust, are cleaned by a sweep of the rubber, and are everlasting.

Among the inferior substitutes the best is a brick wall plastered with cement mortar, finishing with a surface of clear cement, rubbed down when hard with a flat stone and fine sand to a smooth surface, and then

coated with any good blackboard paint. Ordinary plastering, though commonly made use of, is very inferior.

It is best and cheapest to buy the blackboard paints put up in cans by the school furnishing houses under the name of "liquid slating," but an imitation may be made by dissolving gum shellac in very strong alcohol, 95 per cent. at least, and adding fine flour of emery, with lampblack, to the consistency of thin paint. Three coats must be applied. Occasionally the last coat of plastering is colored by adding lampblack, which must first be wet with alcohol or spirits, to enable it to be mixed with the mortar. When this is done it is well to add hydraulic cement to harden the surface. Blackboards may be finished with a small moulding at the top.

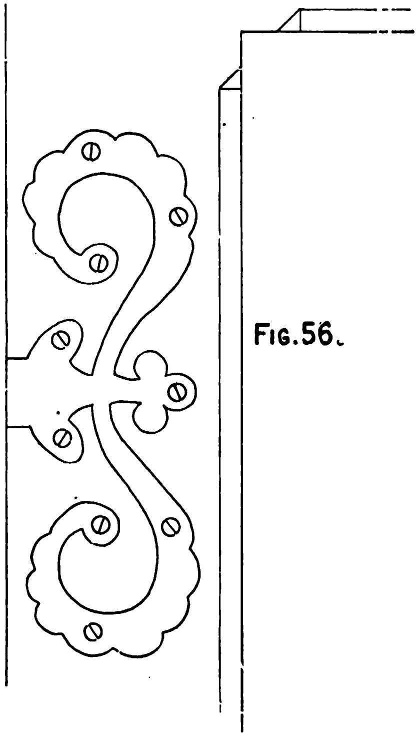


FIG. 56.

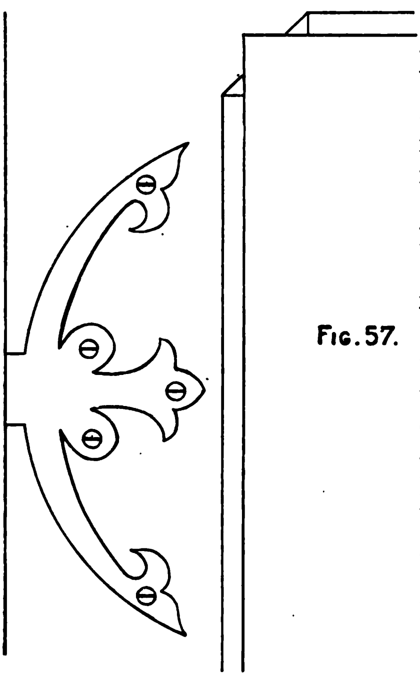


FIG. 57.

Doors may have a picturesque effect given them at small expense by the arrangement of the panels, and a small stopped chamfer on the framing looks well instead of mouldings and costs no more.

Windows should always be double hung, with good lines and weights, and accurately balanced, so as to move with a touch.

All doors should have locks, of good make, and knobs. Thumb latches, though cheap, will tear enough clothes in the first year to pay the extra cost of knobs ten times over. Butt hinges for hanging doors should be japanned, unless door and hinges are to be painted. A pretty effect may be given at small expense by having hinges made to spread out over the face of the door after the fashion of the ancient wrought iron

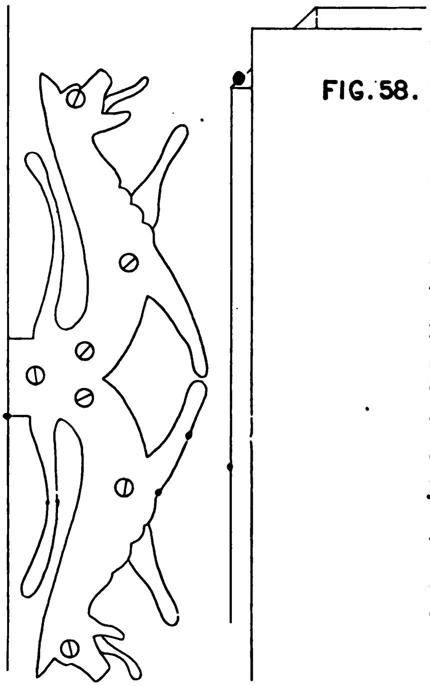


FIG. 58.

work. Some care is required in arranging butt hinges in this manner, so as to have the knuckle come right on both parts, and substitutes, or "shams," as they are justly called, are sometimes used, consisting of a thin plate of some fancy pattern, which is screwed on the door close to the hinge, which is itself an ordinary butt. The plates are thin, flat castings, japanned, with countersunk screw holes, and cost a mere trifle. The pattern is sawed out of thin wood, and the castings of "shams" cost but five or six cents each, all japanned. With knuckles for real hinges, drilled for the pin of the butt, the cost is 18 to 25 cents each. A few specimens are given (Figs. 55, 56, 57, 58, 59, 60).

VENTILATION.

It should be unnecessary at this late day to quote the well worn proofs that air loaded with organic contamination—"school room" air, to give it the specific name by which it is known in the text books of hygiene—is the great source of nervous disorders and depression of the physical powers, of tubercular diseases and consumption: every one knows them by heart. It is not, however, so generally known that children are many times more sensitive to atmospheric poison than adults, and that their natural brightness and activity during their school life, instead of showing that they endure its noxious influences with impunity, only conceal for the time the disorganization of lungs or nervous system which will assert itself when it is too late to remedy it.

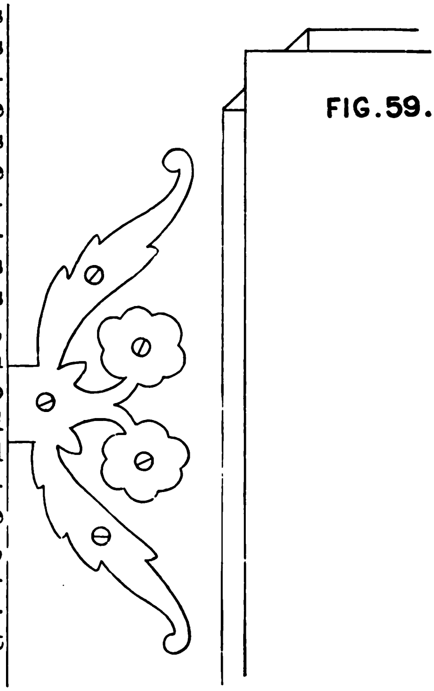


FIG. 59.

Those who control the construction of the large city school-houses are now generally awake to the importance of ventilation, and efforts are made to secure it, with some degree of success; but many country school buildings are not only wholly destitute of any provision for removing foul air, but, being warmed by stoves instead of the furnaces of the larger structures, no fresh air is admitted. Others have openings in walls or ceilings, wooden shafts perhaps, leading into the attic, but without fresh air inlets or means of persuading the foul air to pass through the openings provided for it; in few is there an intelligent comprehension of the end to be attained or adaptation of means to that end. Yet small school-houses are perhaps the easiest of all buildings to ventilate if the object to be secured and the dangers to be avoided are kept in mind.

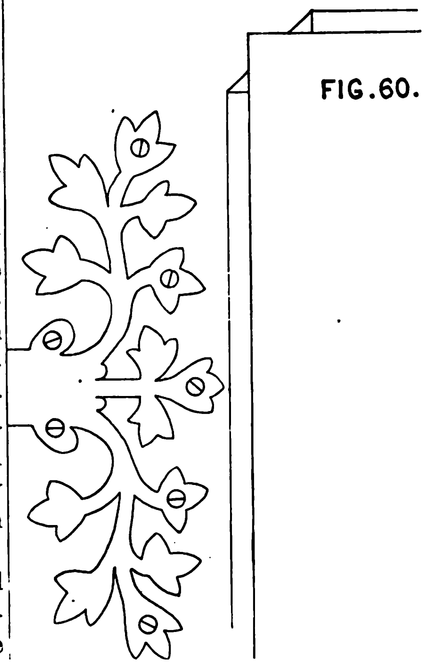


FIG. 60.

Briefly, the aim of ventilation should be to maintain a steady supply of fresh air and withdrawal of foul at all parts of the room, removing the products of respiration and organic particles as fast as thrown off and leaving no corners stagnant or unswept by the purifying current.

This is to be accomplished primarily by means of the windows, which must extend as near the ceiling as possible, so that the air entering by them may blow upon and carry away the organic dust and condensed vapor which collect upon its surface (when undisturbed) to putrefy and diffuse poison through the fresher currents below. The windows should be numerous and easily handled, so placed that by means of them a thorough draught can be immediately obtained, and, most important of all, they must be frequently opened. Nothing can take the place of aeration by means of open windows. Artificial ventilation, though required for changing the air when the windows are necessarily closed, is insufficient, even under the best of circumstances, unless the room is from time to time thoroughly refreshed and purified by the sweep of the free winds through all its windows widely opened. Such an atmospheric washing should be secured three or four times daily in all weathers; at recess, particularly, it should be insisted on, banishing teachers and pupils from the room meanwhile, if necessary. They will more than make up in the brightness of the remaining hours for the time they may thus lose. Immediately after school, morning and afternoon, the process should be

repeated for a longer time, and just before school, also, if the room can be warmed again quickly enough. No fixed transom lights or immovable arched heads should be permitted to exist over the windows, subtracting from the most useful portion of the opening; the large, heavy sashes common in the more pretentious buildings should be rehung with rawhide cord or copper chain if necessary and pulleys with friction rollers balanced so as to move with a touch, while in new buildings the size and weight of the sashes should be carefully kept down, no sash being over 3 feet wide or 1¾ inches thick. Eyes must be fixed to the upper sashes and a pole and hook furnished to handle them with, or, still better, cords fastened to each sash hanging within easy reach and pulleys to raise or lower them at will, and the window frames must be perfectly made, with cherry beads, and looked after from time to time to see that all is in working order.

Besides the general airings in which all the windows are thrown wide open it is possible and very desirable during three-fourths of the year to keep some of them partly open. If they extend to the ceiling, the upper part at least of the south windows, in rooms properly supplied with other fresh air inlets, may be pretty widely opened in the coldest weather without causing a noticeable draught. Such openings, if on the leeward side, often interfere with the action of extraction shafts by drawing to themselves the current of escaping air; but this is of no importance in the buildings we are considering.

There are times, however, when windows cannot be opened, and means must be provided for insuring the withdrawal of the respired air from the room in some other way.

For our simple structures, it is useless to consider the fan machinery for exhaustion and propulsion, by which the uniform passage of measured quantities of fresh air is secured. We must content ourselves with a means less scientific and reliable, but sufficient for our purposes: the extraction shaft, warmed or not, as the case may be.

The powers and properties of air shafts are often so grossly misunderstood that an explanation of their action may be necessary before proceeding to details. Nothing is more common and more absurd than to see rough ventilation flues, 4 by 8 inches, built in walls without any provision for heating them, under the supposition that they will "draw;" or to see tiny pipes, from the foulest places, introduced into chimneys which are cold half the time, in the expectation that the "forced draught" which is imagined to exist there will suck up and carry off deleterious vapor as fast as a square yard of filth can generate it. All talk of "forced ventilation" by means of a shaft without fans or steam jets is misleading. The action of every such shaft or chimney, warmed or not, is precisely analogous to the movement of two boys balanced on a see-saw. If their weight is equal, neither moves; if one is slightly heavier, he descends and the other ascends, but his motion

would not be fairly described by saying that he was "forced into the air." So with ventilating shafts; the column of air in them is balanced against a column of the same size and height outside of them. If the outer air is cold and that in the shaft warm, either from artificial heat or by communicating with a warm room, the latter column will be slightly lighter, because, being expanded, a given volume contains less weight. This difference of weight, if there is not too much friction in the chimney or elsewhere to be overcome, will incline the balance, and the air in the chimney will rise, cold air descending to take its place. The actual difference of weight between the column of air in a chimney 12 inches square and 30 feet high at a temperature of 100° Fahr. and an equivalent volume at 32° Fahr. would be 5 ounces; and this, deducting the friction of both the ascending and descending currents, will be the measure of the ascensive force of the air in the shaft.

Without artificial heat the ascensive power is much less—infinitesimal often; and in summer the current in a chimney is at least half the time reversed, the evaporation of the hygrometric dampness of the masonry cooling the air within it below the temperature of the surrounding atmosphere.

This force, feeble though it be, is all we have to depend upon, and it need hardly be said that all obstructions to its action must be avoided. The common cause of defective action is insufficient fresh air supply.

The movement of the balance depends wholly on the freedom of action of both its sides, and the heated column has no force to spare for sucking in cold air through inadequate openings to supply the place which it leaves; still less has it the power of going off by itself, leaving a vacuum behind; unless the cold air is ready in equal measure to supply its place, the warmer column will wait for it—in other words, stagnate—and there will be no draught. This is the condition of most existing ventilation flues nine-tenths of the year, as is easily shown by holding a light handkerchief before them.

Vice versa, if fresh air is to be introduced into a room, provision must be made for the escape of foul air. The simple experiment of attempting to blow into the mouth of a bottle will impress this fact upon the mind, and will show why it is that many rooms supplied with hot air from furnaces cannot be warmed until a window or other outlet is opened, allowing the pent up atmosphere to escape and the fresh supply to enter in its place.

In order, then, that there may be a flow of air through the room, not only must the withdrawing shaft be large, straight, and smooth, that the inevitable friction of the air upon its walls may not materially obstruct the outward flow, but the inlet openings must be also ample and unobstructed, any hindrance to the inward flow being equally a check to the outward current. To use a homely illustration, the room to be ventilated may be imagined to be traversed by the lower end of a huge

atmospheric roller towel. It makes no difference whether we pull one side down or the other side up to secure a movement; but if the towel is obstructed in any part of its course the whole is brought to a stand still. Recollecting also that to pull down a common roller towel actually takes more power than the whole force ordinarily available for moving the entire atmosphere of a large room, the total ascensive power of the usual ventilating shaft seldom exceeding one or two ounces, the imperative necessity for avoiding friction will be evident.

The principal means to this end is the enlargement of the shafts, the friction increasing only directly as the perimeter while the capacity increases as its square. For this reason a round shaft two feet in diameter will carry off about as much air as six shafts each one foot in diameter, and in square pipes the difference is still greater. Besides being large, the shaft must be straight, an elbow constituting a very serious obstruction; and it must be round or square, and as smooth as possible, to lessen the friction against its walls.

For the inlets the same precautions are necessary; but the task is easier, as they may be short. For the outlet or ascending side of the roller, a certain height is needful, as the force increases with the length of the warm column; but the descending side is formed of the whole outside air, and only tubing enough is necessary to introduce it into the room. It is, therefore, much easier to provide sufficient inlet than outlet. Inlets, however, have a difficulty of their own, that is, the necessity for avoiding cold currents or draughts from them, a difficulty not to be surmounted without considerable trouble. The best way is to introduce warm and cold air together through the same registers so as to temper the mixture in winter. How this can be best done under varying circumstances will be described in the following matter under the head of "Heating." We have now to determine the amount of air which should pass through the room in a given time, on which depend the size of the outlet and inlet pipes and subsequently the modes of inducing a current in these pipes, on which their efficiency depends.

The amount of fresh air which is allowed to hospital patients is about 2,500 cubic feet each per hour. Criminals in French prisons have to content themselves with 1,500 cubic feet per hour. Assuming that we care two-thirds as much for the health of our children as we do for that of our thieves and murderers, we will make them an allowance of 1,000 cubic feet each per hour. Forty-eight children will then need an hourly supply of 48,000 cubic feet. Definite provision must therefore be made for withdrawing this quantity of foul air. No matter how many inlets there may be, the fresh air will only enter as fast as the foul escapes, and this can only escape through ducts intended for that purpose, porous walls and crevices serving in cool weather only for inward flow. What, then, must be the size of the shaft to exhaust 48,000 cubic feet per hour? In shafts 2 feet or more in diameter the velocity of the cur-

rent varies with the height and with the difference in temperature between the atmosphere inside and that outside. In one 20 feet high, vertical, and smooth inside, with a difference in temperature of 20 degrees, the velocity will be about $2\frac{1}{2}$ feet per second, or 9,000 feet per hour; that is, it will carry off 9,000 cubic feet of air per hour for every square foot of its sectional area. To convey 48,000 cubic feet it must have a sectional area of $5\frac{1}{3}$ square feet.

Such a difference of temperature corresponds to that of the season when it is too warm to light the fire and too cold to open the windows, and for this season the ventilation should be adapted.

But in winter, the difference of temperature being much greater, the velocity will be increased, and the shaft, especially if warmed artificially, will exhaust more than is necessary, if the inlets will supply it. How is this to be provided for? The best way is to open the outlet shaft into the room by two registers, one near the floor and the other near the ceiling, the net opening of each register being equal to a little more than one-half the sectional area of the flue. If iron register fronts are employed, each one must be the whole size of the flue. The iron work occupying one-third of their area and the obstruction caused by the clinging of the air to the surfaces which it passes over deducting also from the effective opening, the net capacity of each register so used will be about half its superficies.

With this arrangement, opening both registers gives the full capacity of the flue for spring and autumn; in winter, partially or wholly closing the upper one reduces the capacity of the outlet in proportion to the acceleration of the current. The lower valve should be left always open; by this means, when the upper one is closed in cold weather, the greater ascensive force or draught at that season is utilized to draw downward from the ceiling the fresh warm air which issues from the furnace air chambers, and by virtue of its lightness accumulates at the top of the room, thus changing the whole atmosphere of the apartment and bringing the warmer layers down to where they are needed—about the bodies of the occupants. During the milder months, there is not power enough in the shaft to overcome the inertia of the upper strata of air in the room so far as to draw them down to the floor, and if only the lower valve is open, even though it be the full size of the shaft, they remain stagnant, the shaft supplying itself by a current which sweeps along the floor from the nearest inlet. By opening at such times the upper valve also, not only is the total capacity of extraction doubled, but the air is drawn from top and bottom at once, and thoroughly changed.

In hot weather the movement through the outlet shaft practically ceases; but at such times the buildings of which we treat will be ventilated by the windows. There are, however, many days in which the weather is not warm enough for open windows, yet the motion of the air in the "aspiration" shaft is too sluggish for effectual ventilation, even with both valves open. For such times artificial means of inducing a

current are valuable, as indeed they are at all seasons, for reënforcing the natural draught, feeble at best. When the thermometer in the shaft stands at 65° and out of doors at 0°, the difference of 65° represents an ascensive force or draught which, when the outer air stands at 50°, would require a temperature the whole height of the shaft of 115°, or rather more. To raise the air entering from the room at, say, 65° to anything near this temperature, which is not far from that of an ordinary smoke flue, evidently requires some artificial means. The simplest is to connect the actual smoke flue from the heating apparatus with the ventilation shaft. Then the air in the latter will be warmed by contact with the heated walls of the former. The two flues may be of brick, with a 4-inch with between, or the smoke flues may be of metal, carried up inside the air shaft. Riveted copper and cast iron pipes are used for this purpose, and even vitrified or terra cotta drainpipes may be employed. Of course, no assistance whatever is derived from these sources unless there is a fire in the furnace or stove with which the smoke pipe is connected, and, as was said above, the warmer the weather the less will be the natural draught and the hotter must be the fire built to aid it. This is inconvenient, although in the majority of cases it is the best arrangement practicable. A more manageable, but more costly, means of artificial aspiration consists in the maintenance of a special fire within the flue itself, either a grate full of coal or a gas or oil flame. Some such motive power is necessary when artificial ventilation is to be carried on through the summer; but to be of any use it must be widely different from the feeble flames which are so often imagined to be "forcing" a current through an air flue. In summer, with air outside and inside at the same point, to cause a withdrawal of 48,000 cubic feet of air per hour, the minimum allowance for a room containing 48 children, through a shaft 2½ feet square inside, will require the consumption of not less than 20 feet of gas per hour. The cooler the season the greater will be the natural draught and the less gas will be needed; but an expenditure of half that amount is out of the question for school purposes, and less than this would be merely delusive. So with the steam coils which are often introduced: in the majority of cases the obstruction which their bulk presents to the current is at least equivalent to the assistance derived from their heating qualities.

A partial exception should be made in favor of a system of aspiration, applied by Mr. Henry A. Gouge, 47 Beekman street, New York, and covered by his patents, so that application must be made to him for license to use it. The principle on which this depends is illustrated by the following experiment: Blow through a small tube toward a candle flame at a distance; it will be feebly affected. Blow in the same manner through a larger tube; the effort will be dispersed and lost. Again, blow through both tubes, holding the end of the small one a little way within the other—experiment will show the proper distance—the candle will be strongly affected, the current through the lesser pipe seeming to

be reënforced by an induced current entering at the open end of the large one.

In applying this principle to the ventilation of rooms, the main extraction shaft of the size required is cut off at a certain point, leaving the lower end open. A smaller metal pipe, five or six inches square, is inserted a little way into this open end, and at the bottom of the small pipe is placed a lamp or gas-jet. The strong though slender current, produced by the flame burning in so confined a space, passing quickly upward into the mouth of the large shaft, induces in this shaft a movement of the air greater than would be effected by the same expenditure of fuel in the ordinary way.

Some one of these means of maintaining a current may be very useful under certain circumstances. In ordinary cases such quickening of the draught in the air shaft as is afforded by connecting it with the smoke-flue is, combined with thorough and frequent airing by open windows, all that can be attempted. There will be damp days in spring and autumn when this is ineffectual, but, if outlets and inlets are large enough and unobstructed, such days will not be numerous.

The shafts must, however, be tight to be of much use. The wooden ducts, so commonly employed, warp and crack, retarding the current by the escape and diffusion of the air. The upper register must also close tightly, or it will be impossible to draw the warm air down to the lower one for winter ventilation. Wooden sliding or hinged shutters can be made pretty close, but metal registers and valves are better. Those made by W. G. Creamer & Co., 96 John street, New York, have a lip on the valves, which assists tight closing.

Besides the ventilation of the school room proper, it is of great use to provide for the discharge of the intensely heated air which in summer collects under the roof. The general rule applies here, that without inlet there will be no outflow, so that two or more openings must be made. The most effectual plan is to construct an open ventilator at the highest part of the roof, and leave openings between the feet of the rafters all around. This effectually clears the roof space of hot air, the movement being stronger as the heat of the sun is greater. Another less thorough way consists in making openings, protected by blind-slats, at two points in the roof, in gables or dormers. If the wind is favorable, the air is by this means slowly changed.

Special ventilation is often needed for particular points, as wardrobes, water closets, &c. For these it is generally sufficient to bear in mind the rule that without both inlet and outlet of about equal capacity there will be no effective current; with them, the days are few in which there will not be some change of air, though it may be slow.

It is not absolutely necessary that the outlet shaft should be vertical. In some cases, where it is difficult to carry up a flue, tubes carried horizontally in two different directions to the outside of the building will

work well. The wind pressure being never the same at the mouth of both tubes, air will enter through one and flow out through the other.

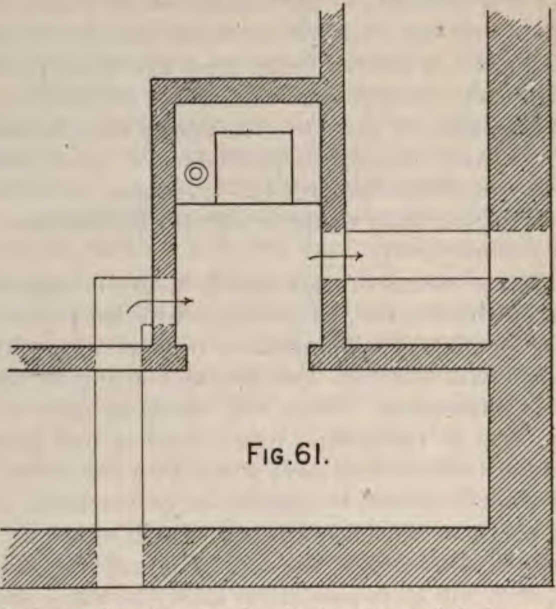


FIG. 61.

The ventilation of privy vaults is treated of below under "Sanitation."

It is a disputed point whether the galvanized iron caps, of which so many forms are sold, assist the action of ventilating flues. That they do not in practice accelerate the current is made certain by rigid tests of many varieties, but they do not materially obstruct it, and the best will generally but not always prevent down draughts where the flue is situated near a higher roof or a hill.

HEATING.

Shall the school room be heated by shutting out all fresh air, starting an air tight stove or a steam radiator, and parboiling the bodies and brains of the children in an unchanged atmosphere reeking with carbonic acid and organic exhalations? This will save fuel, but waste life. Fresh air must be admitted at any cost. How is the fresh air to be introduced, cold from the outside or warmed in transitu? If it enters cold, those nearest the inlet will suffer from the chilling draught. Unquestionably it must be warmed before it enters the room.

Then the problem of heating is solved; 48,000 cubic feet of fresh air per hour, the minimum allowance for a school of 48 children, must be raised from the out-of-door temperature to 70° and discharged into the room. Any heating apparatus which will do this is suitable, and none is suitable which will not.

In practice, heating stoves or furnaces raise a comparatively small

unt of air, that which actually comes in contact with their radiating sur-
s, to a temperature of 100° to 200°; and this is subsequently mixed
ι a sufficient quantity of cool air to give an average atmosphere at
There is nothing objectionable in this, provided the warmer com-
ent is not so heated as to char and decompose the dust floating in it,
provided also that the cool portion of the mixture is derived fresh
ι out of doors, and is not simply the foul air of the room, which has
ι cooled by stagnation, and, drifting near the furnace register, is
ght up and sent into renewed circulation. This will be the case
ss supplies both of hot and cold air are introduced together from out
oors in such a way that if the current from the register is too warm
ay be tempered by increasing the proportion of fresh cold air in the
ture at the same time that the proportion of warm air is diminished;
as is the ordinary arrangement, by shutting the register, and thus
ing off all supply of fresh air of any kind. With such a system, keep-
the admission of fresh air the same at all times, regulating its tem-
ιture by varying the proportion of its two component parts, supple-
ted by suitable shafts for withdrawal of foul air, winter heating and
tilation are easily managed.

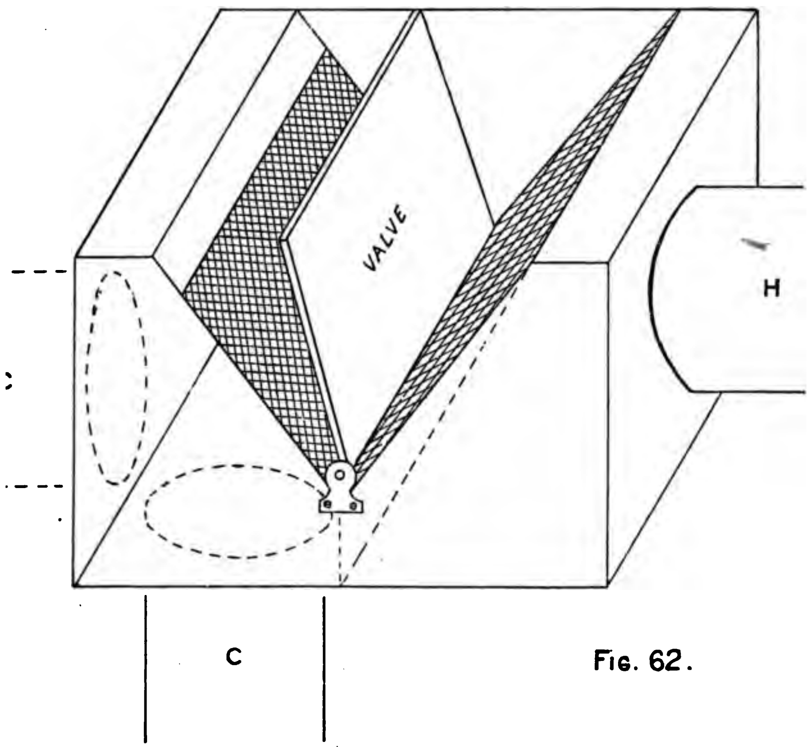


Fig. 62.

'ig. 62 shows a suitable device for effecting this mixture of warm and
l fresh air in the register box of an ordinary furnace, but there are
ıy other ways.

The register box is shown in section: H is the usual tin pipe from the hot air chamber of the furnace. C is a similar cold air pipe leading from out of doors or from the cold air box of the furnace. The pipe C may be introduced either below or at the side.

So far, there is no difference between this and an ordinary register box. To apply the regulating valve, strips of tin are soldered to the sides of the box, with a low partition through the middle, and to this fixed partition is hinged a tin flap, stiffened by wiring the edges. Nothing more is needed but to take out the valves of an ordinary register and arrange the button by a short wire lever to act upon the flap.

To diffuse the hot and cold air, wire gauze may be put over the inclined mouth of each division and a sheet of the same may be spread under the register plate itself. This will mix the two currents and prevent unpleasant draughts, and the size of the registers may easily be made larger to compensate for the obstruction to the flow so caused.

This disposition of registers is practicable with any form of basement furnace. Where the room is warmed by stoves a different arrangement is necessary, the principle of which was explained by Franklin a century ago, and consists simply in bringing cold fresh air from out of doors by a duct which directs it against the radiating surface of the stove, from which it passes warmed into the room. An application of this principle may be made with any common stove by carrying a tin or wooden pipe from the outer air to a point beneath it, and directing it upward through a hole in the floor under the stove. A part will come in contact with the hot iron and be warmed, while the rest escapes unchanged, but the whole will be pure. An improvement on this consists of a galvanized iron or zinc casing around the stove, by which the incoming air is held longer in contact with it and more thoroughly warmed. These, however, are wasteful make shifts. The "school stoves," of which many kinds are manufactured, accomplish the same end far more economically and thoroughly.

Figure 63 shows the construction of that made by Mr. John Grossius, 389 Main street, Cincinnati, Ohio, the direction of the pure air from outside within the casing and on the hot surface to its escape through the open top being easily seen. It is in fact a small hot air furnace. Similar ones are sold by the New England School Furnishing Company, Boston; A. Lotze's Sons, Cincinnati; L. W. Leeds, New York, and many other parties.

Another heater much used in schools is the so called Fire on the Hearth stove, made by the Open Stove Ventilating Company, 78 Beekman street, New York, which differs from the preceding mainly in having an open front, so that it can be used either as an air tight stove or an open fire. Where it can stand at a distance sufficient to prevent scorching the faces of the scholars, the open fire quality is very desirable. The radiation from the mass of coals warms the floor and the feet of the children in front, and the ventilation afforded by the draught of the fire

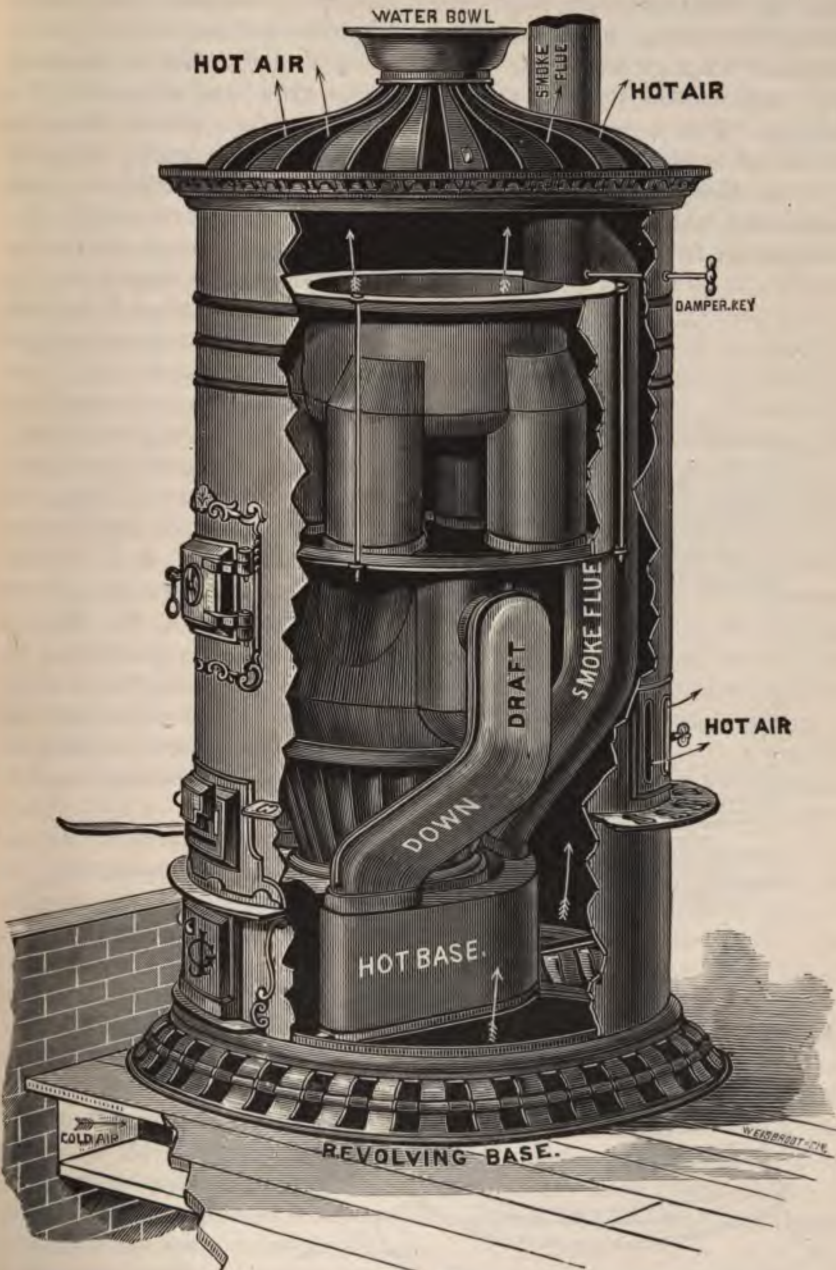
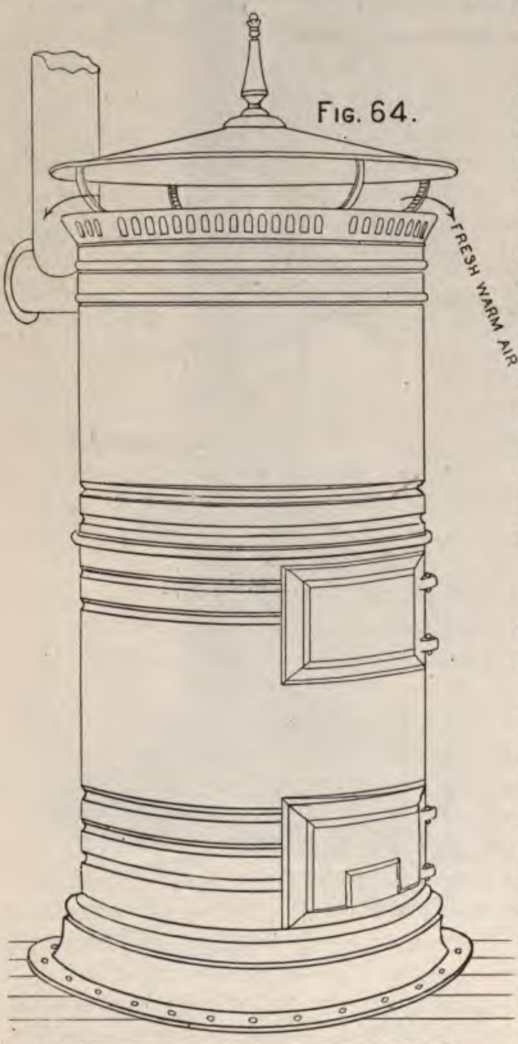

WATER BOWL
HOT AIR
SMOKE FLUE
HOT AIR
DAMPER.KEY
SMOKE FLUE
DRAFT
DOWN
HOT AIR
HOT BASE.
COLD AIR
REVOLVING BASE.

FIG. 63.

is very considerable. Indeed, many small school-houses are warmed and ventilated wholly by means of one of these stoves with the front open, the fresh air supply entering beneath, being warmed in its passage through the casing, and issuing at the top, whence it rises to the ceiling, circulates through the room, and becoming cool and foul at the same time, settles to the floor, is drawn in at the grate, and escapes up the chimney. This is perfect in principle, and is very much better than no ventilation at all, but is inadequate to the needs of forty or fifty children. With the blower on and closed, this stove affords no ventilation worth mentioning, unless a separate exhaust shaft is provided to draw off after vitiation the fresh air which it furnishes, and thus allow more to come in. The same is the case with the other heaters described.

FIG. 64.



An improvement might easily be made in these stoves by arranging registers in such a way that the incoming air should be thrown into the room after a longer or shorter contact with the hot surface, at pleasure. Under the present arrangement the temperature of the room is regulated by quickening or slackening the fire, a comparatively slow process; by the improvement we propose it could be changed in a few minutes.

A few practical suggestions on the management of stoves and furnaces may be kept in mind.

Difficulty is sometimes found in directing the hot air supplied from the registers to the desired points. The school stoves, particularly in a high room, send the warm air directly up to the ceiling, and the lower part of the room must wait until the upper regions are completely filled before it can enjoy the heat. The Fire on the Hearth stove obviates this

difficulty to a great extent by its powerful draught, which immediately sets up a circulation from the upper strata to those nearest the floor, and a good ventilating shaft with the lower register only open accomplishes the same result; but a still more speedy effect may be obtained by suspending a shallow screen of sheet-metal over the stove, by which the ascending current is directed outward and downward so as to reach the occupants of the room at once, becoming also thoroughly intermingled with the general body of air. The Boston school stoves (Fig. 64) are made with this appendage, which can be easily added to any form of apparatus. Furnace registers often need similar screens to direct their current toward or away from any particular point.

It is much disputed whether furnace registers should be in walls or floor, or, if in the wall, at what height. For large buildings with strong ventilation the best position seems to be in the wall, 6 feet or so above the floor. Then the current warms to some extent the lower strata of the atmosphere of the room, without blowing directly upon any one, and the tendency of the hot air to collect at the ceiling is counteracted by the draught toward the lower register of the ventilating shaft.

Where the ventilation is as feeble as it will generally be without fans or special sources of heat in the shaft, this tendency of the hot current to rise out of reach cannot be overcome, and although the fresh warm air, like an inverted lake filling up from below, finally reaches the occupants of the room, much of its heat is wasted in warming the ceiling, so that for such cases, which include most small buildings, the best position for registers will be either low in the wall, and directed so that the strong horizontal current from them will not annoy any one, or in the floor, where the natural disposition of the air to rise is counteracted by its clinging to the floor, along which it travels horizontally a considerable distance before leaving it to ascend to the upper regions. Floor registers are liable to gather dust; they must be kept clean.

An inconvenient breeze from a register, either hot or cold, may be lessened without diminishing the supply of air, by widening the box or pipe in trumpet shape, with the mouth toward the exit, and putting on a larger register plate. Wire gauze either over or under the register will also do much to diffuse the current gently.

Furnaces should be set under the northwest corner of the building, and registers may be placed in the four angles; the greater length of pipe needed to reach the southern registers, and the consequent obstruction by friction, will be compensated by the natural circulation of the air in the room, upward on the sunny side and downward on the cold side, so that the delivery will be uniform at all the registers, which it will not be if the furnace is centrally placed. Stoves also heat more equally if set in the coldest corner.

Registers and the so called ventilating stoves should not be situated so near the opening of the ventilating shaft that the air from them will be drawn into the shaft as fast as delivered. The best position is at the

same end of the room as the shaft, but at one side. Then, the lower inlet only of the shaft being open, the upward tendency of the warm, fresh air from the heater will carry it up out of reach before it can be drawn laterally far enough to enter the shaft. It will then move along the ceiling to the further end of the room, descend to the floor by cooling, and be drawn back into the ventilator only after a circulation through the room more extended and thorough than could be attained with any other relative position of outlet and inlet.

A serious difficulty is often experienced, both with basement furnaces and ventilating stoves, through the action of the wind on the exterior opening of the cold air box or other fresh air supply. It is customary to direct these toward the north or northwest, and the result is that with a high wind from that quarter the air is driven through the air chamber of the furnace and up through the registers much faster than it can be warmed.

The usual remedy is to close the damper in the air box, so that the sectional area of the inward current shall be diminished in proportion to its increased velocity. If the air box were tight and the wind steady this would be correct, but in practice the wind comes in puffs, to guard against which the damper is too much closed, and the normal supply of air being thus curtailed the furnace, to make up the deficiency, draws from the cellar, through the cracks and pores of the air chamber and box, such air as it can find.

If, on the contrary, the sheltered side of the building is chosen for taking in fresh air supply, a strong wind from the opposite quarter will create a vacuum on the lee side of the house strong enough to reverse the natural current, and draw air out of the building through the reg-

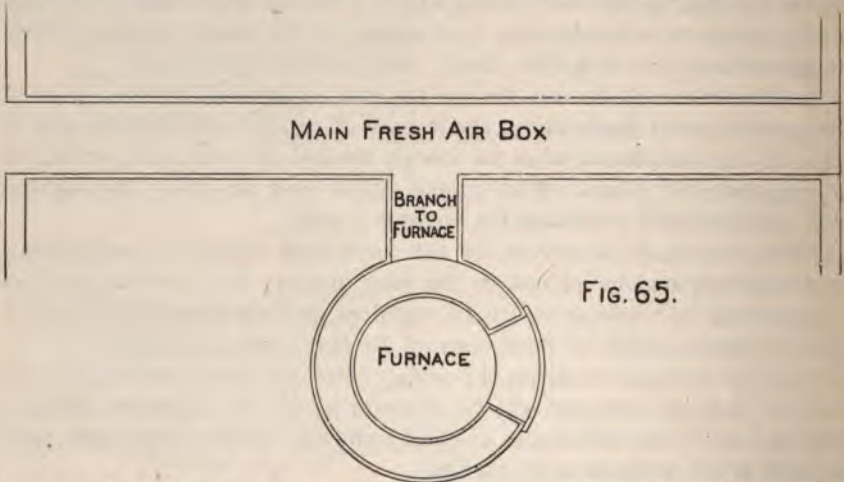


FIG. 65.

isters and air chamber of the furnace, the warm air issuing at the orifice where the cold should go in. This is not a rare occurrence, and cannot be remedied without some trouble.

To obviate both these difficulties and insure a steady and sufficient supply to the stove or furnace at all times, it is only necessary to carry the cold air box through the building, with orifices at each end; the furnace is then supplied by means of a short pipe, drawing from the side of the main box at right angles with it. (Fig. 65.) The wind may then blow through the main box at will without disturbing the furnace, which takes from the stream just what it needs and no more. Where several registers are to be supplied with cold fresh air for mixing with warm, a similar large main box, tapped at right angles by the minor pipes, forms much the best arrangement.

If the force of the wind still makes itself felt in the rooms, a further check may be found in a screen made of two thicknesses of wire gauze, with wool loosely picked and spread between them. Independent of its use for checking the force of the current, this "air filter" is valuable for straining out dust and soot where the fresh air supply is unavoidably taken from a street or other dusty place.

There is much controversy as to the relative merits of cast and wrought iron furnaces. As a rule, more science has been expended on the cast iron varieties and they radiate better and are more economical of fuel than the plate iron forms, which are often nothing more than a simple cylinder inverted over the grate; but it is probable that furnace joints soon become pervious to carbonic oxide gas, and plate iron forms the most reliable security against the mixing of the air with minute quantities of atmospheric poison.

The qualities to be sought for in wrought iron as well as in cast furnaces are tight joints, strength of metal, and the greatest possible extent of radiating surface. The greater the surface the more thoroughly the air will be warmed, such a furnace discharging large volumes of air all at a moderate temperature, while one with small radiating surface sends out a mixture of much cold with a small quantity of highly heated air.

Among the appliances for regulating furnaces, the automatic heat governors should be mentioned. These, by means of the expansion or contraction of rods passing through the air chamber, act upon the check draught damper and the lower door of the furnace, increasing the fire when the temperature in the air chamber falls and checking it when it rises, either by a change in the weather or by the closing of registers above. For so simple and inexpensive an apparatus ($15) it is singularly useful.

In many cases open fireplaces will be used in preference to any kind of stove. There is a very mistaken idea that any room with an open fireplace is sufficiently ventilated, summer and winter, without further apparatus. In winter, it is true, the chimney may be used as an exhaust shaft, so far as its capacity extends, and its action will be increased by the heat of the fire at its foot, but its usefulness depends much on the provision of suitable inlets of fresh air. In warmer weather the im-

pure air collects at the top of the room, and the difference in tempera ture between the atmosphere within and that without is too small to se up a current capable of drawing down the stagnant upper strata to th floor.

Even if the capacity of the flue should be sufficient for winter vent lation, a separate shaft with an opening at the top is required for sprin and fall. The once common practice of putting a register in the smoke flue, near the top of the room, sometimes with but oftener without light valves held open by a spring, but blowing to with any down draught, is too dangerous to be countenanced. The valves, if used, may rust and stick, and such openings have been known to give vent suddenly to sheets of flame.

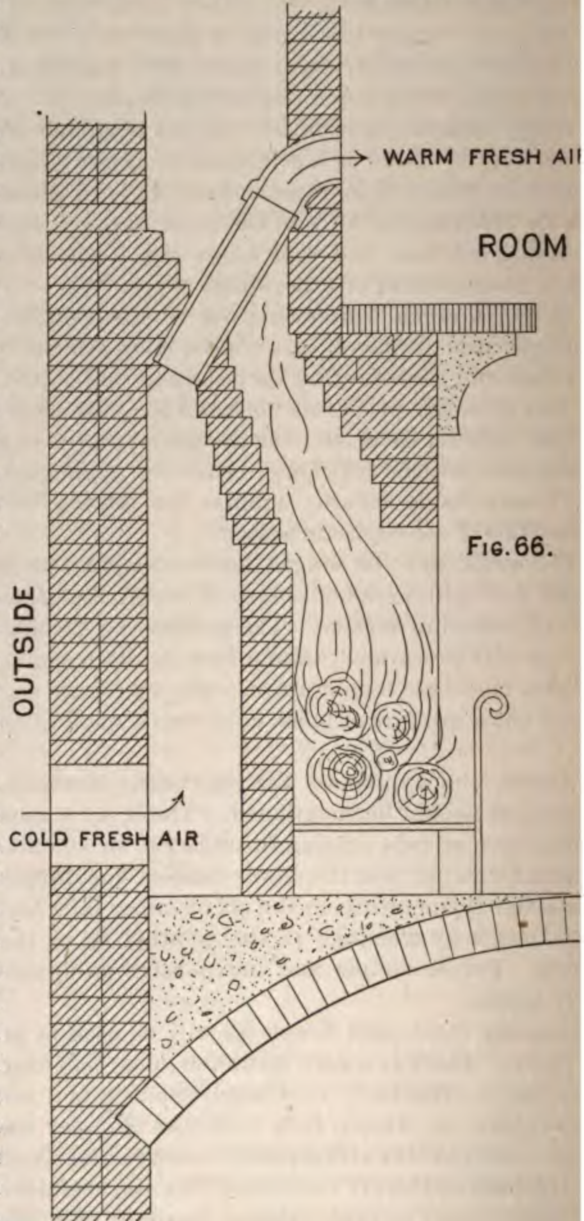


FIG. 66.

The fresh air inlets, wherever open fires are used, must be ample and so placed that their current will not annoy the occupants of the room. Usually, no special inlet is provided, and the fire takes its air where it can find it, sucking it in in small streams through the crevices of doors and windows, walls and floors. These small draughts of cold air, drawn directly from out of doors and crossing the room *straight to the fire,*

are both uncomfortable and dangerous. A sufficient supply should be specially provided; then these secondary currents will cease. The best way to obtain this supply is by means of a flue passing through or near the fireplace, with an opening at the bottom to the exterior air and another into the room, if possible above the mantel, so that the fresh air, thus warmed, may not be drawn directly into the fireplace but may rise to the ceiling and circulate through the room until sufficiently cooled to descend to the floor, be drawn back to the fire, and consumed or driven off up the chimney. There are endless ways of effecting this; any intelligent mason can accomplish it. One way is to build a false back to the fire place, carrying flues from it to the front of the breast (Fig. 66) above the mantel. These cross flues may be made of brick, or bits of drain pipe can be built in. The heat around them and against the false back warms the air effectually. Still better would be a similar apparatus of iron, but the materials may not be at hand, and a large Fire on the Hearth stove would answer the same purpose better at less expense. Even the roughest chimney may have a similar flue built up at the side instead of the back, with opening in the side of the breast and an opening to the external air at the bottom. (Fig. 67.) The air will be less easily warmed than where the partition is of brick or iron, but to compensate for this the fires in such rough chimneys are likely to be made without sparing fuel.

The homely buildings in which pebble stone or log chimneys are used will be particularly benefited by such an air supply flue; not that they lack ventilation, but because their seams and cracks, from the moment that the fire discovers an easier source of supply, will cease to admit cold draughts. If the flue for fresh warmed air is large enough (it should be considerably larger than the smoke flue), the pressure at the crevices around the walls will be rather outward than inward.

SANITATION.

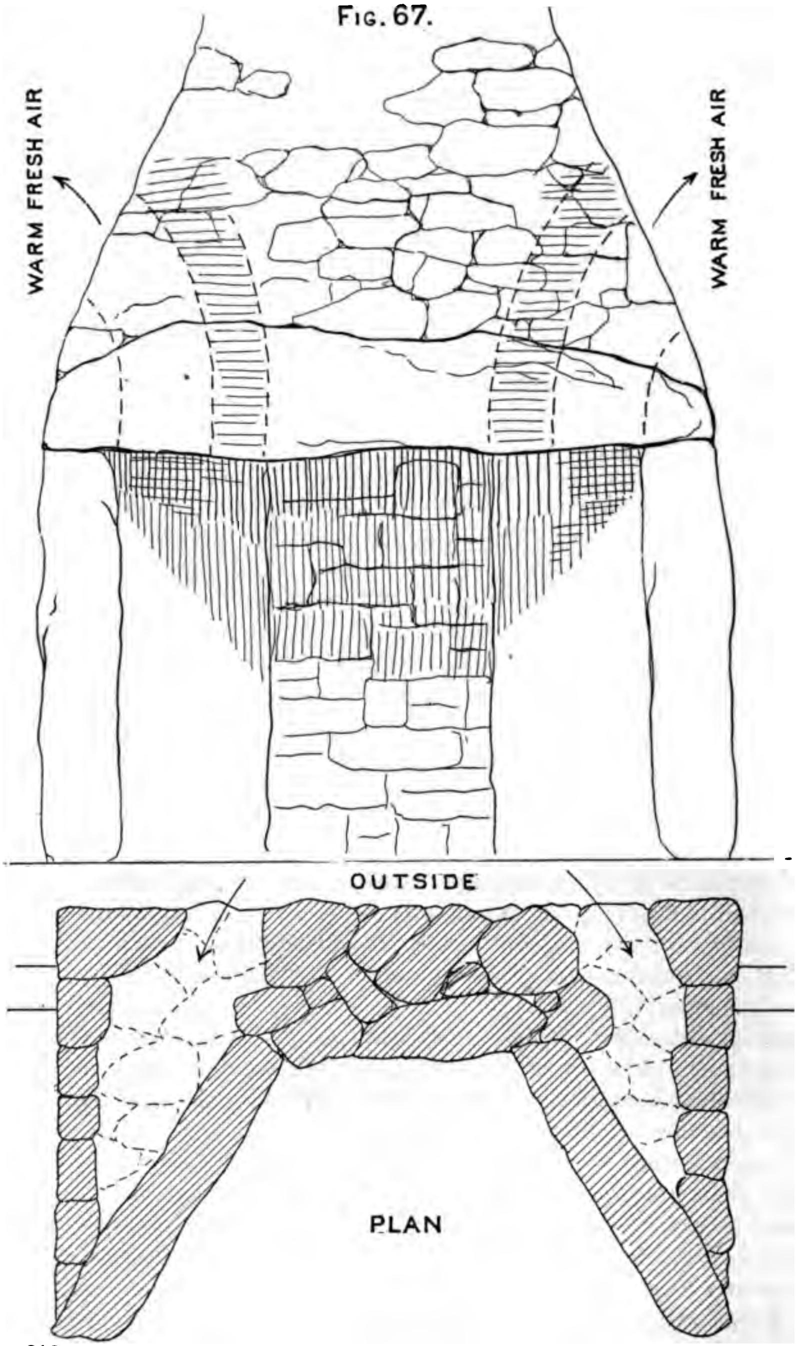
If the principles of ventilation, heating, location, and construction, as described in the foregoing pages, are intelligently applied to school buildings, little more can be done to preserve the health of their inmates, and if any of them are neglected no amount of attention to the others will make amends.

The importance of guarding the water supply of the school from contamination has already been dwelt upon, and frequent inspection of the ground whence are derived the springs which feed the well should prevent subsequent defilement.

In the building itself, the imperative necessity for preserving the cellar air clean and sweet must never be forgotten; basement laboratories or storerooms for chemicals, kerosene, or even coal and wood, should be avoided. If these precautions are observed, the only probable remaining source of impurity will be the sinks or bowls and closets. Of these the bowls will give no trouble if drained into a separate "dry well,"

consisting of a pit some 2 or 3 barrels in capacity, filled with loose stones and sodded over, or still better a line of 50 to 100 feet of sole tile, laid end to end, about a foot below the surface of the ground, and

FIG. 67.



the joints covered with a bit of paper or handful of hay before filling up the trench. The water discharged from the school washbowls is comparatively so clean that there is hardly a possibility of the outlet choking with sediment. It is otherwise with the water closet drainage, which will in time fill up the pores of any soil. The usual course, to postpone as long as possible the evil day when the cesspool must be cleaned out, by making it of great size, is unwise. Aside from the increased cost, the large accumulation of material is at all times much more offensive and dangerous than a small one, and the cleaning out, when it comes, is horrible, while the pumping out of a small reservoir once a week or so is not a serious matter. The best cesspool is a tight tank of brickwork in cement, with brick or concrete bottom and a stone top set in cement. The stone cover may, with advantage, have a common iron pump fixed in it, by means of which the contents of the tank may be pumped out whenever required with the least trouble.

In addition, the cesspool cover should be drilled with a number of holes for admission of air. If the tank is far from the building, it is best to put a trap in the drain pipe, near the house wall. In this case, there will be a constant small effluvium from the cesspool, but, unless it is too large, not enough to reach the building. If space is restricted, the drain pipe should be without a trap and the soil pipes carried well up above the roof. Then the natural warmth of soil pipes and cesspool will cause an upward flow in the now unobstructed line of pipe, the air being drawn in through the holes in the stone cover instead of issuing therefrom, and will be discharged harmlessly into the upper air.

An overflow is usually necessary to any tight cesspool which is in danger of being neglected. This may be carried to a small dry well or other outlet, where its offensiveness will do as little harm as possible.

In many places these dry wells or leaching cesspools will for economy's sake be employed to do the whole work, regardless of the gradual poisoning of the subsoil inseparable from their use. Even in this case, it is well to remember that a small brick tank for first receiving the drainage and allowing it to settle and dissolve is of much value in preventing the clogging of the soil around the leaching pit.

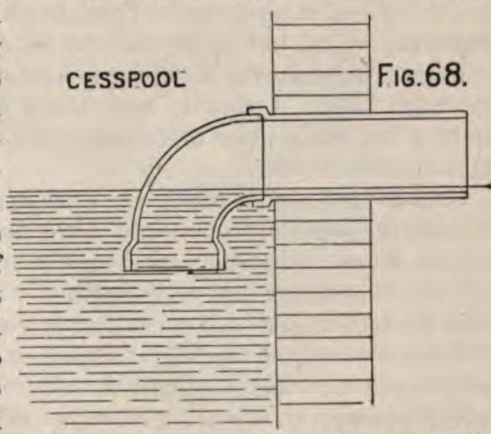


FIG. 68.

The overflow pipe should be built into the wall about half its diameter below the inlet pipe, and a quarter bend should be previously cemented in, so that when set this will dip below the surface of the liquid in the cesspool. (Fig. 68.) By this means, the scum and paper which

always float on the top will be prevented from entering and choking the overflow pipe.

The drain pipe should be of vitrified earthenware outside the building, jointed with cement and the joints scraped out clean. Inside or under the house nothing should be used but cast iron of the best possible make and jointed with melted lead. Four pounds of lead is not too much for each joint in a four-inch pipe, and it must be well caulked in. This soil pipe must be carried well up above the roof, and the end left open. If this is not done, the flow of water through the traps will at times siphon them out, leaving free communication between the house and the interior of the drain, and any expansion in hot weather of the air contained in the soil pipe will force bubbles through the traps to contaminate the atmosphere of the rooms.

These points being properly arranged, there will be, with good water closets, well set, nothing to fear from the plumbing. With plenty of water, the best closets are the enamelled hoppers with enamelled traps, supplied automatically by a tank with siphon or "tumbler," so as to flush all the closets once in ten minutes through the day. This is also an economical arrangement, as one tank will supply a number of closets, but consumes much water. Next in cleanliness as well as in consumption of water come the Jennings and Demarest closets, then the Hellyer, American Defiance, Climax, and Whirlpool varieties; last, the common pan closets. Hoppers without abundant, and if possible automatic, flushing are liable to become nuisances.

The evils of pan closets are much mitigated by using only those with enamelled receivers, but, common as they are, none remain long free from offense. All the varieties may be arranged for automatic action, the valves being operated by the opening and shutting of the door or pressure on the seat, and this is strongly to be recommended.

Many large schools use the latrines made by J. L. Mott & Co., New York, and others, which consist of a long trough filled with water, which is emptied and flushed two or three times daily by a janitor or servant. These are useful, but hardly suitable for small schools.

In general, whatever plumbing is used should be of the best and most thorough kind. A country-built house with country plumbing is apt to be a dangerous place to inhabit, and school houses and public buildings are even worse.

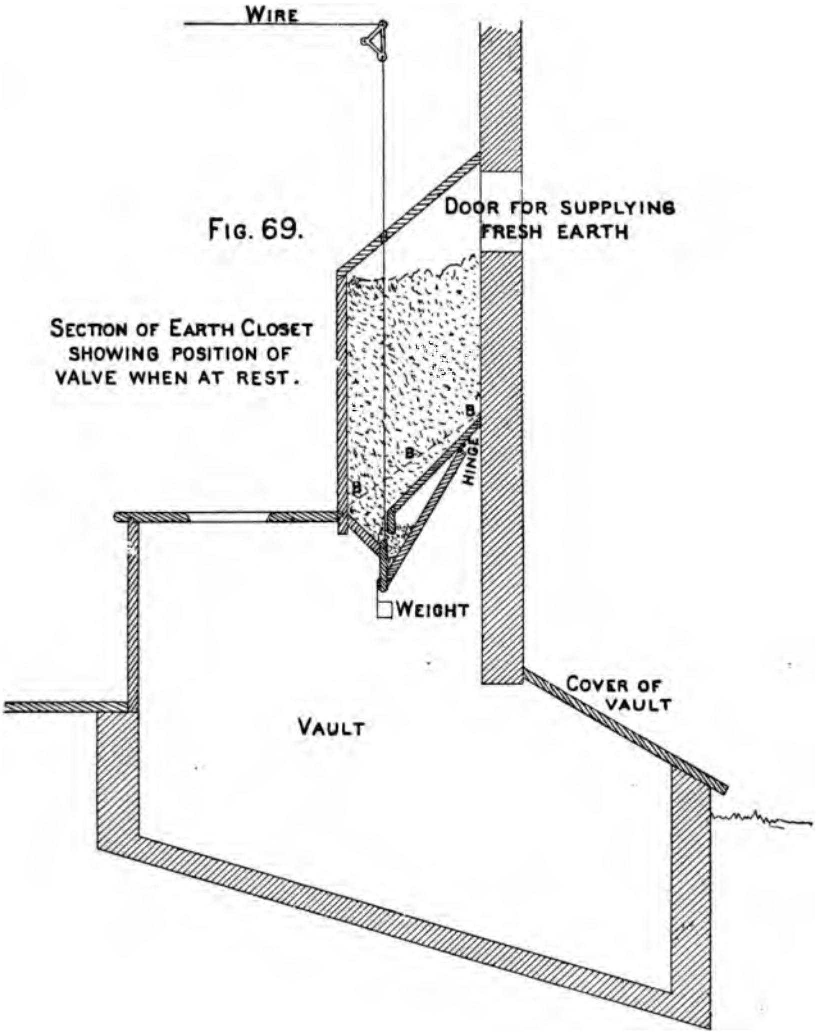
Urinals become exceedingly offensive unless well looked after. Wherever possible, they should have floor and partitions of slate or marble, for easy washing, and should in any case be in a well aired place. A piece of common bar soap is often placed in urinals to lessen the odor from them and is of considerable use.

Earth closets, which will in the majority of cases form the most available appliance, differ only from a well arranged privy in the fittings by which at intervals a small quantity of sifted dry earth is thrown on the matter in the vault. A very small quantity, if evenly spread, acts as

a complete disinfectant, and earth closets are nearly as free from offense as the best water closets—much more so than inferior ones—with the advantages of simplicity, cheapness, and availability in cold weather.

The simpler the apparatus the better; those for house use often come provided with springs for automatic sprinkling of the earth, slides to

FIG. 69.



enclose the receptacle when not in use, &c., all of which are best dispensed with in schools. Not knowing of any ready made appliance exactly suited to the mode of treatment which he proposes, the writer suggests the following, which works well in the model at least.

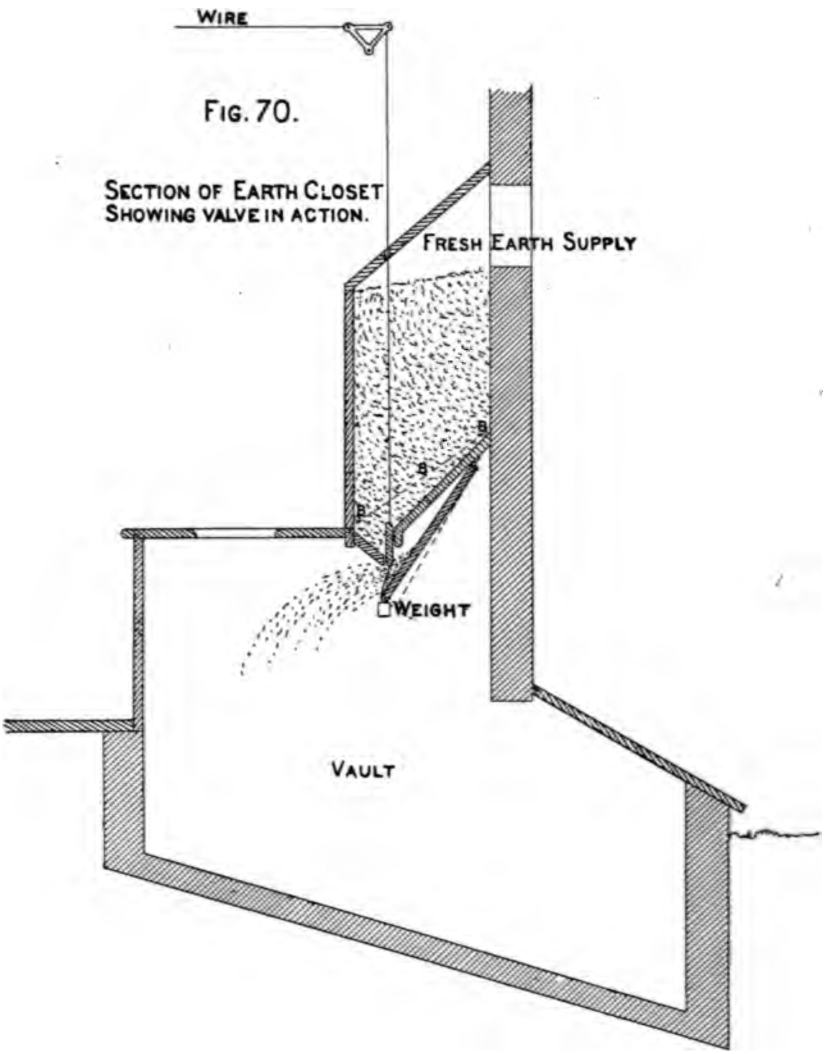
What is needed is a capacious reservoir for the dried earth, a measurer to receive from the reservoir a certain small quantity, and a means of

throwing out the earth contained in the measurer at will in a uniform sheet over the vault, after which operation another given dose should fall into the measurer, to be ready for the next operation.

In Figs. 69 and 70 the reservoir or hopper is filled with a shovel from the outside through the opening. A lid of plain boards is hinged to the

FIG. 70.

SECTION OF EARTH CLOSET SHOWING VALVE IN ACTION.



back of the hopper. Fig. 69 shows it at rest, the weight of the earth holding the lid back and the opening being closed by a slide. By pushing in a lever, pulling a cord, or other means, the inverted lid is thrown

forward, as shown in Fig. 70, and the slide raised, shutting off the descent of earth from the hopper above into the measurer, but throwing the portion already contained in it over the vault in a uniform sheet. On the relaxing of the impulse the weight draws the slide back and supplies the measurer with a fresh dose. By regulating the front edge of the measurer the sheet of earth may be directed as required. B B B is a sheet of wire netting fixed in the hopper, which serves to sift the earth and to prevent it from packing so firmly in the bottom as to impede the movement of the measurer. The jar communicated to the apparatus shakes down the earth, a matter of some importance. Very possibly there may be better modes of accomplishing the same result; the writer merely suggests this as illustrating the end to be attained and the simplicity of means desirable.

A separate box may be fitted to every seat, or one may serve for two or three. Perhaps the best means for discharging the earth will be by cords under the supervision of the teacher.

The vault may, with advantage, consist of tight plank boxes on wheels, so as to be easily rolled out for emptying. If this is impracticable, a shallow pit lined with 8-inch brickwork in cement, and with bottom of bricks on edge, also laid in cement, is necessary, and for facility of cleaning the bottom may slope outward. The vault should be accessible from the outside, but closed by strong and tight doors with lock and key.

The earth used in these closets should be loam or clay, not sand. It should be dried in the sun or by a fire, sifted, and stored in a dry place. The screen for sifting should have about three meshes to the inch; and coal ashes, similarly sifted, may be added to the mixture in quantity equal to the earth without harm. Wood ashes or lime should not be used.

The earth taken out of the vaults may be dried and used over again indefinitely. It retains no trace of the organic matter which it has helped to decompose. The quantity required may be easily calculated. About 1½ pints, or 2½ pounds, of average earth per closet will generally be enough for each discharge, supposing these to take place four or five times daily; and the capacity of the reservoir divided by this will give the length of the interval between successive fillings. If several relays of earth are dried and stored in barrels, there need be no interruption to the working of the apparatus.

A privy is simply an earth closet without the disinfecting earth, and needs no further description. The vault should be small, built of brick in cement, with brick bottom sloping toward the rear, and tight door for cleaning out, as described above. In addition, the vault should be provided with a ventilating pipe, carried up well above the roof. This is best of galvanized iron, but may be of wood if perfectly tight. The doors opening into the vault should be made tight with list or weather moulding, and all crevices cemented up. If this is thoroughly done, there will be a pretty constant current of air downward through the seats,

thence up through the shaft into the atmosphere, and no odor will be perceived even directly over the seat. The top of the ventilating shaft should be protected by a cap if higher roofs about it are likely to cause down draughts. Unless the vault is tight, no ventilation will prevent stench from the saturated soil around it.

ACOUSTICS.

The dimensions of school-rooms are generally fixed by other considerations, but some attention may be paid to acoustic quality without detriment to the other uses of the building.

The most common mistake is in making the room too high. Anything over 13 feet is likely in a room not over 40 feet square to cause that confusion of sounds and echoes which constitutes what is called a "noisy" room. Twelve feet is still better as to this point. Painted or impervious walls also promote echo and noisiness, and the dampness of fresh plaster, closing its pores like paint, often causes the same unpleasant effect, which however disappears as the wall dries out.

Little can be done to cure such a room, if originally wrongly proportioned, except putting in a new ceiling hung below the old.

Occasionally echoes from the blank end walls may annoy teachers or scholars. Something may be done to remedy this by hanging maps or any soft elastic substance against the offending wall. If desks are placed next the side walls, which should never be the case, there is very likely to be an indistinctness of sound there, from the intermingling of sound waves transmitted at different velocities through the air and along the solid substance and reflected from the rear. This can be partly remedied by cutting off the rear angles of the room by a board set in the corner, as at X; but the desks should be moved away from the walls. (Fig. 71.)

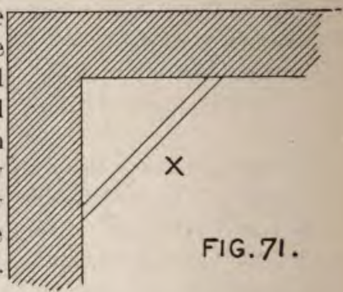


FIG. 71.

ATTRACTIVENESS AND ECONOMY IN BUILDING.

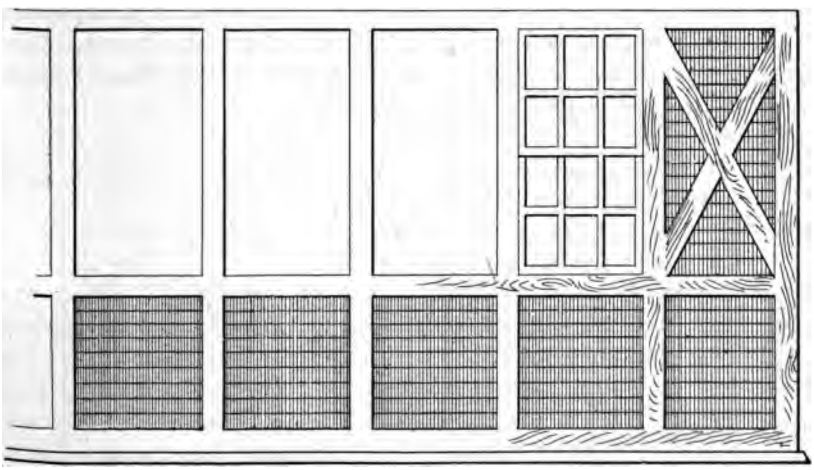
These two qualities are perhaps not altogether compatible, at least not in their highest development; but it is rare to find any building which does not show some sacrifice to appearance, and with care and knowledge little expenditure is needed to secure some measure of picturesque beauty. For this, however, the first requisite is good construction. Elaboration of detail only adds to the repulsiveness of a structure tainted with premature decay. To begin with frame structures, all woodwork should be kept from contact with earth, and even when brought into juxtaposition with masonry should be well painted to repel the inevitable dampness. The end grain of timber needs most to be protected, and the tenons of beams framed into girders. The end joints

of clapboards, especially where they abut against a casings or corner boards and all similar points, may with great advantage be coated with paint before the parts are brought together. This will prevent the springing out of clapboards or siding at ends through the breaking away by incipient rotting of the wood around the nails in those places, which soon disfigures buildings not well cared for. In the same way, plank walks and outside woodwork will keep in good condition much longer if the ends of the planks are painted.

Another important though commonly neglected point is the use of galvanized nails for putting on clapboards and outside finish. The usual way is to employ ordinary nails and "set in" the heads far enough to allow a little putty to be daubed over them before painting the second coat. This keeps the water out till the builder gets his pay. Soon afterwards the continual shrinking and swelling of the boards by the vicissitudes of weather open a little crack around the putty, through which moisture penetrates, to exude again, leaving a rusty streak below every nail hole. In dwelling-houses painted every five years or so, this is less important, but neglect must be assumed to be the normal condition of school-houses, and its evil effects must be provided against so far as practicable in the first place.

All other points of strength and quality of material should be well looked after. Gutter irons should not be over 30 inches apart; shingles should not show more than one-third their length to the weather; clapboards 6 inches wide should lap at least $1\frac{1}{2}$ inches; the tops of door and

FIG. 72.



window casings should be rebated or flashed with sheet lead to prevent the entry of water over them; door and window stools should pitch sharply to throw water quickly off; and, as a rule, eaves should have considerable projection, a matter of importance in promoting the dryness of the building.

It is very common to dispense with gutters in small rural buildings; but the constant dripping of eaves without them wears away the grass in an irregular and untidy line around the edifice.

If the construction is judicious and the materials are good and used with due regard to their properties, not trying to bend straight clapboards around circular projections or to glue up narrow boards into fictitious panels of immoderate size, little is necessary to satisfy the eye at least. By painting in a variety of tints, a wide field is opened for giving interest to the plainest structure.

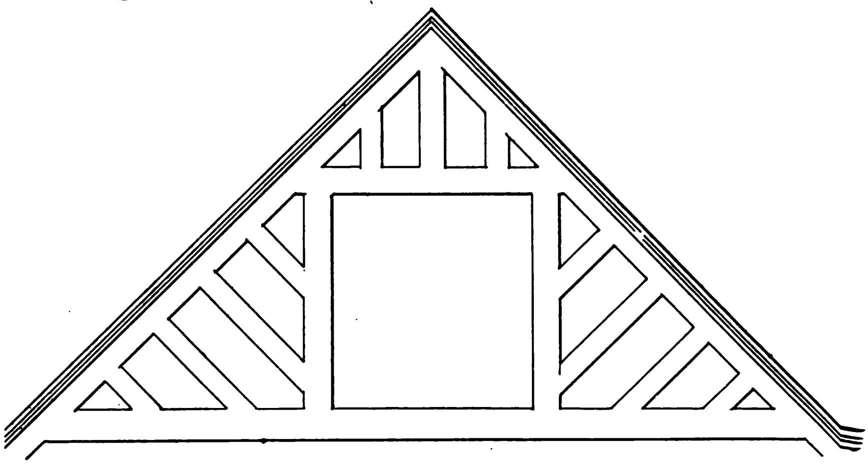


FIG. 73.

To begin with the most humble efforts at color decoration, a pleasant harmony may be obtained by leaving the shingles and siding boards of a frame structure unpainted, covering only the corner boards and "finish" with light red. The mineral reds answer well, if brightened with yellow ochre, and are cheap. Doors should have red panels and unpainted stiles, or vice versa. Where the windows are numerous and the finish work forms a comparatively large proportion of the surface, great picturesqueness may be given by painting the siding, leaving casings, corner boards, belts, and roof plain. (Fig. 72.) The harmony of gray and pink or rose color, which a few months of weathering gives the work, is peculiarly pleasant when treated in the latter mode.

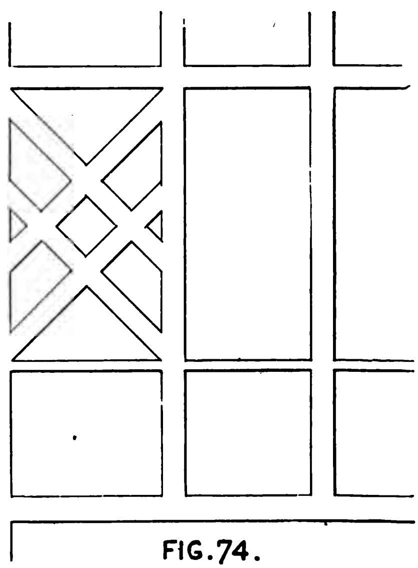


FIG. 74.

In order to manage the color effect nicely with any combination

of tints, it is often desirable to break up a surface which would otherwise give too large a mass of one shade by belts or bands in various patterns. These may be readily and cheaply made by putting boards directly

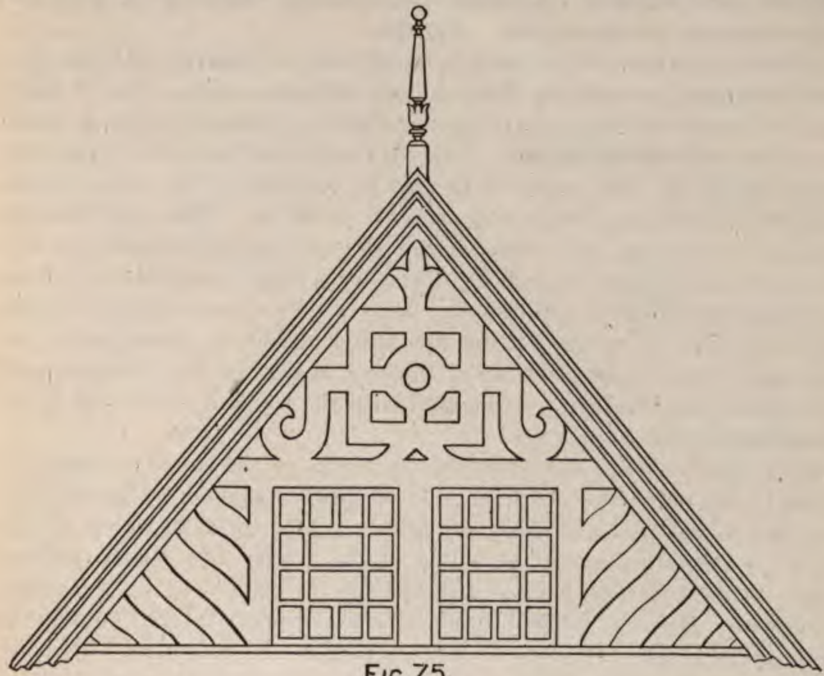


Fig. 75.

over the shingles or clapboarding. In this way there will be no need of "grafting" or flashings, which are necessary where the bands are nailed on the under boarding and shingled or clapboarded up to in the common way, and the effect is if anything rather in favor of the cheaper mode, which gives more projection than the other. Figs. 73, 74, and 75 give a variety of suggestions.

A little ingenuity will secure much beauty with two colors, the principal point being to avoid heavy masses of unbroken tint. Every opportunity should be seized for changing from one color to the other, especially about porches and balustrades, which demand delicate treatment.

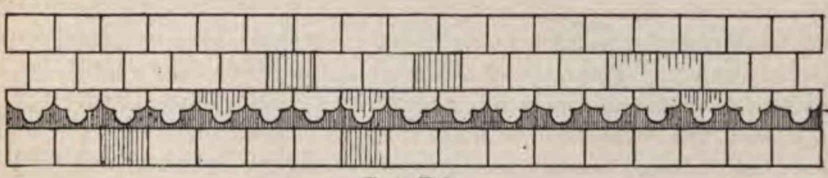


Fig. 76.

It will often be found, however, that the porch detail is too small for the rest of the building, which looks heavy and clumsy by contrast. In

this case, a corresponding delicacy may be suggested in the main portion by a narrow belt or two, or a row of shingles with cut ends may be carried around it, and the intervals, being painted of a different color, will present a chain of colored points, restoring smallness of scale and "preciousness" to the whole. (Fig. 76.)

Where the whole of the outside woodwork is painted, the best effect will be found in employing three or four different colors. One of these should always in the country be an olive or brownish green, to recall and as it were tie the building down to the general surface of grass and earth about it. The other tints may be varieties of the same green, made by modifying it with blue, yellow, or brown. This, with the roof painted a brownish red, using any of the red mineral pigments now in the market, will give a pleasant effect, especially if touches of red are introduced at different points in the mass of green, as on window sashes, brackets, ends of rafters, panel mouldings of doors, turned work, &c. If a more lively impression upon the eye is desired the indispensable olive green may be boldly associated with the red and violet, which will complete the full color scale.

It is said by some oculists that the retina of the eye is composed of three layers of nerve substance, one of which responds to green rays, another to red, and the third to violet. White light, in which all the rays are contained, calls the whole of the retina into action; colored light, on the contrary, excites only its special layer, leaving the others quiescent. Hence it follows that in observing party-colored objects the optic nerve is more or less unequally brought into action, and in consequence unpleasantly affected, according as the proportions of the various hues depart from or approach that proportion which would stimulate the three sensitive layers equally. When this proportion is reached, whether by pure colors or subtle mixtures, the eye experiences a sensation of rest and satisfaction. This is what is meant by the term "color harmony." Just what are the relative proportions and the shades of color which constitute perfect harmony we cannot yet say. In general, if the three quasi primary colors, red, green, and violet, are presented of equal intensity and in equal areas, the eye will be roughly satisfied.

For our purpose, the violet may be represented by the dark "slate paints" sold for putting on roofs, modified by admixture of other pigments if desired. The green should be of an olive cast and the red may be any warm ochrey color not too dark. The red is likely to be the most intense of the three; if so, it must present proportionately less surface, and in the same way the area of the other colors must be in inverse proportion to their intensity to keep the balance right. Some ingenuity will be required in managing the colored surfaces. The roof, if it shows about one-third of the total visual area, may be painted with the slate color at once. If it shows more, the violet should be lightened or modified; if less, intensified. To divide the red and green equally, *excuses must* be sought for painting gables, for coloring the wall beneath

; differently from that above, showing doors with red panels in framework, and so on. In case of necessity, the red can be so ified with vermilion that its area may be made relatively small. ss combinations will suggest themselves to any one who once un- .nds the simple principles from which he should work.

'e complex harmonies may be tried in reserving, say, a portion of 'een, separating it into blue and yellow, and with these decorating nent points; or, by keeping the green of a bluish cast, enough ellow, so to speak, will be liberated to enliven gables or similar .. It is safest, however, to experiment with the tints rather sub-

de the building, decoration must necessarily be restrained. The ling frescoes of battle scenes and deeds of heroism which some to see on school room walls are hardly for our day; the best we ›pe for will be coarse maps or diagrams. Ceilings should be white, e sake of their reflected light. Floors and woodwork offer some tunity for picturesque effect. The former, in the districts where walnut is abundant, may at trifling expense be laid with alternate of this and a lighter wood, pine or spruce. Refuse walnut may ›d, white sap not being a serious defect for this purpose. The floor l be laid without a border, which cannot, unless special prepara- ; made for it, be nailed firmly enough for school-house wear.

ι similar manner, doors and wainscot may have panels of one wood raming of another. White wood (tulip or basswood) panels, in ›r spruce framing, look well; if oiled, they quickly turn to a brown . Cap mouldings of wainscots may be dark wood and panels or members may be painted, leaving the remaining parts natural or ifferent color. Bronze green framing may have Indian red panels, e versa, and so on. All these things help to "dress up" a room, ιough too violent for private dwellings they are not so for a school- and do much to keep it looking bright and fresh without increas- s cost.

ↄk buildings need less exterior decoration; massiveness is their r quality, and whatever increases the impression of this helps the of the building. Reveals, that is, the sides of the window and door ιes, should be deep. For instance, in a 16-inch hollow wall it is ›le either to put the window frame near the inside of the wall, ιg 12 inches of brick surface to form the outer part of the recess, set the frame only 4 inches back from the general wall surface, in ι case there will be a considerable interior reveal, to be plastered ed with wood. Of these two modes, the former has much the bet- ›pearance.

th brick or stone walls a peculiarly picturesque and pleasant effect 'en by using tiles for roof covering instead of slates or shingles. › made at Akron, Ohio, by Merrill, Ewart & Co., have projecting which much improve the tightness of the roof laid with them.

Without some such device ordinary tile roofs will admit dry, drifting snow, unless made of very steep pitch, but it is safe to use them where only rain is to be feared.

It is very fashionable in England to paint the woodwork of brick buildings—sashes and frames of windows, doors, and balustrades—white, and the effect is pleasant. The sash bars are made quite thick—seven-eighths of an inch, instead of the five-eighths usual with us—to avoid the spider web look of the lines, and small lights are used. In some cases the frames and sashes are even gilded, so there is no want of example for the exercise of fancy in decoration of this kind. Figs. 77, 78, and 79 show different modes of treating the model plan. Fig. 80 shows a small English school-house recently built.

SPECIFICATIONS AND CONTRACTS.

It only remains to suggest models for specifications and contracts which shall be suitable for ordinary cases. To present a separate model for each kind of building, brick, stone, and wood, is unnecessary; any one can make the requisite changes to suit a given specification to one or the other construction. What seems most essential is that the model shall include *all* that is needed for a particular building. Then, for a structure of the same kind, the specification can be adopted entire, with assurance that there is nothing omitted, and for one of a different sort the completeness of the model will help to call attention to all the points which need modification.

In the same way, in regard to contracts, there is much less danger that an intelligent committee or superintendent will be unable to modify a given form to adapt it to various circumstances than that, if the model before them is too general or incomplete, as such models usually are, they will not be able from their own experience to supply those numerous clauses and conditions for want of which serious trouble may afterward arise.

It seems best, therefore, to give a full specification for an ordinary frame structure of the best and most thorough kind; such a one as an architect desirous of saving his employers from bills of extras would think it necessary to use. Following this is a form of contract which, though much longer than the agreements that are frequently used, is as condensed as it can be without leaving out clauses which, though in nine cases out of ten needless, the tenth time become of great importance. It is the essence of a good contract that it shall leave no contingency unprovided for. Long experience has shown that all the emergencies contemplated in this model are liable to occur, and it is for the benefit both of builder and owner to have their rights and duties in such cases defined beforehand, so that no apology is needed for the length of the document. It will rarely be necessary to call in a lawyer to draw up such papers, unless some very unusual stipulation is to be introduced.

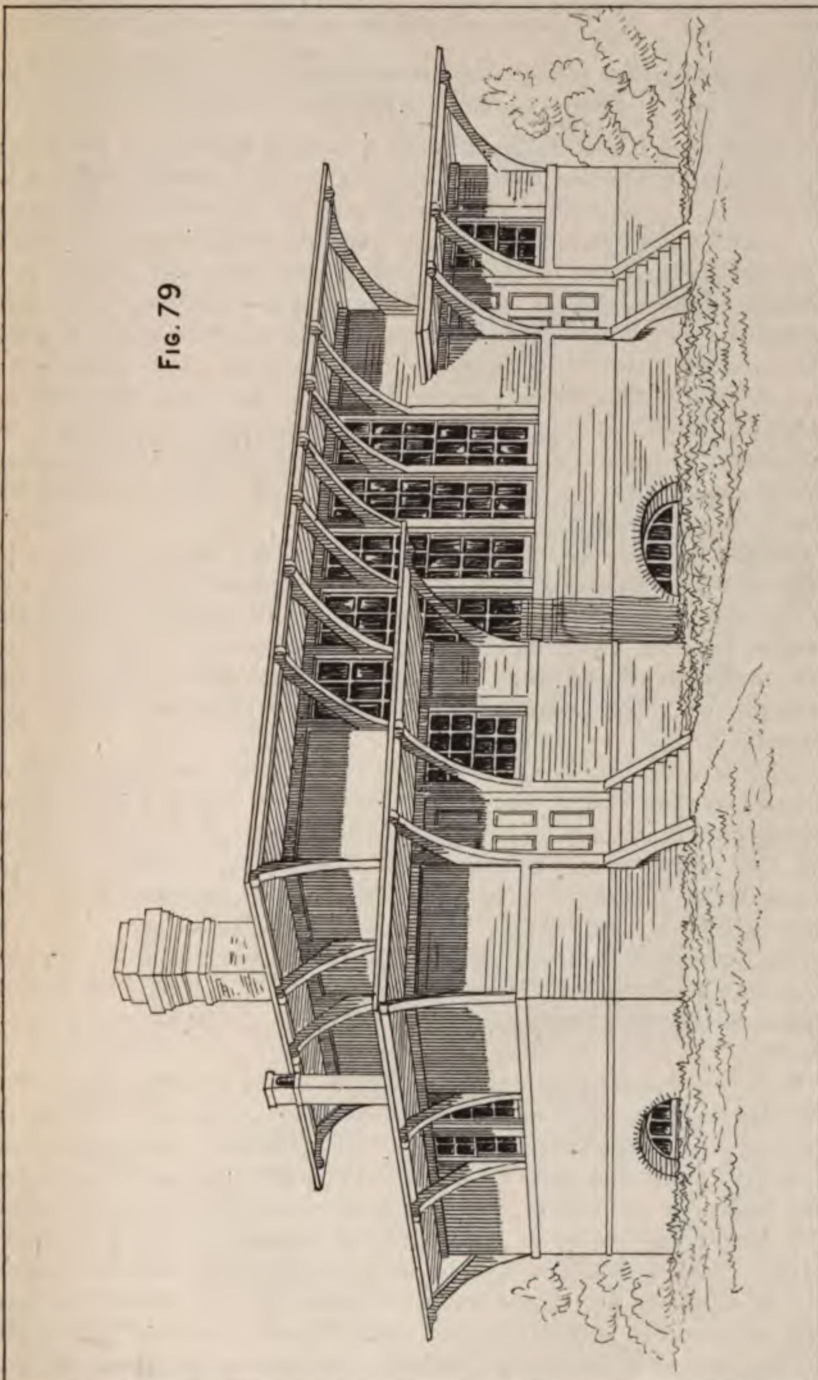


Fig. 79

MODEL FOR SPECIFICATIONS.

Mason's specification for school-house to be built for the inhabitants of the town of X on their land on Y street.

Excavation.—Excavate the cellar to a uniform depth of 3½ feet below the highest point of the ground which the building covers, making the excavation 8 inches wider all around than the outside of foundation walls, as marked on plan; excavate trenches for all walls and piers 2 feet below cellar bottom; excavate trench 4 feet deep and 100 feet long for drain pipe; and excavate for setting posts of porch 4 feet deep, and for cesspool as shown on plan. Separate the loam and stack by itself where directed, and dump the other earth from the excavations wherever directed within 200 feet of the building. Excavate for bulkhead to cellar. Refill about cellar walls with gravel. Refill around cesspool and posts. Level and grade neatly about the building as directed, and put the loam on top. Clear away and remove all rubbish and leave the ground in good order.

Blasting.—If any blasting should be necessary for excavating the cellar as above specified, seven cents (more or less) per cubic foot will be allowed by the town for blasting and removing the stone, and all the stone so removed which may be suitable shall be used in building the cellar walls, and for all stone so taken from the cellar and used in the walls the town shall be credited at the rate of seven cents (more or less) per cubic foot.

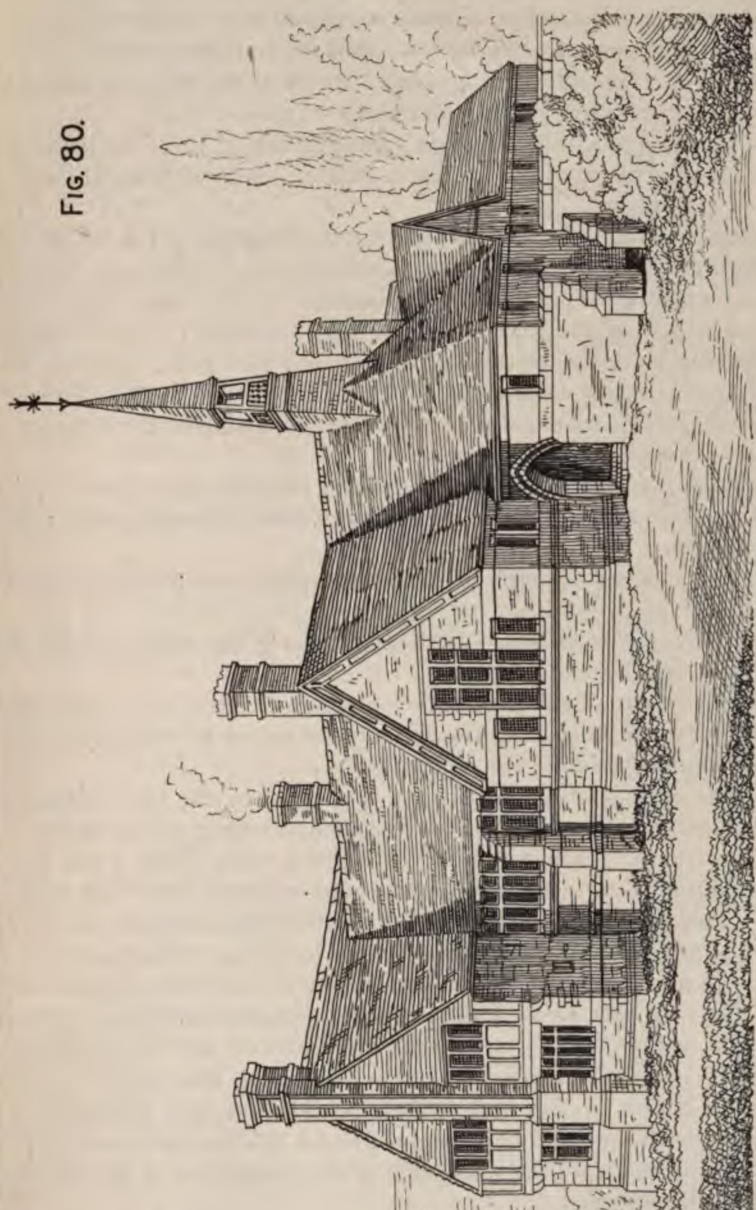
Drain-pipe.—Furnish and lay in the best manner from cellar wall to cesspool 100 feet of first quality (*Portland*, *Akron Scotch*) 6-inch glazed earthenware drain pipe, to be jointed with clear fresh Portland cement and the joints scraped smooth inside as laid; all uniformly graded. Leave the line of pipes open until inspected and approved, then refill the trench with earth, the last 12 inches of filling to be loam.

Foundations.—All the lime used in the mason work to be No. 1 extra Rockland, Rockport, or Thomaston (*Canaan*, *Glen's Falls*, &c.), and all cement to be fresh Rosendale (*Akron*, *Louisville*, *Portland*) of the ——— brand.

Walls.—Furnish all materials and build cellar wall as follows: Put first into the trenches 18 inches in depth of quarry chips or broken stone, dry, and upon this build the walls 18 inches thick in ledge stone laid in mortar made with lime and cement in equal parts and clean sharp sand in proper proportion; the wall to be well bonded, the joints filled with mortar, and the whole trowel pointed outside and inside the whole height. Set the best face of the stones outside, both above and below ground. Set footing stones for piers and chimneys. Build bulkhead walls of stone in cement mortar, neatly faced. Bed the sill of the building in cement mortar, and bed and point up around frames of basement windows.

Cesspool.—Build a tight brick circular cesspool 5 feet inside diameter

FIG. 80.



and 5 feet deep below spring of arch, the walls to be 8 inches thick, of hard brick in cement. Dome over the top 4 inches thick, and lay the bottom 4 inches thick, all of hard brick in cement. Leave manhole 20 inches in diameter, and cover with a 3-inch bluestone 2 feet square, with hole cut in the top and iron grating. Build in the overflow and inlet pipes. Carry overflow to small dry well.

Brick-work: Piers.—Build (*four*) piers in cellar, 12 by 12 inches, to under side of girders, of hard brick in mortar made with equal parts of lime and cement.

Chimneys.—Build chimneys, as shown on drawings, of hard brick in lime mortar to under side of roof boarding, above roof to be selected brick in mortar made with one part cement to two parts clean sharp sand (no lime), and the four upper courses to be laid in clear cement; all withs to be 4 inches thick, bonded into the walls, and all flues carried up separately to the top. Plaster every flue inside, brushing the mortar smooth with a wet brush, and the outside of the chimney to under side of roof boarding.

Provide and set iron thimbles and cover for stove pipe (*furnace*) and two 20 by 30 Creamer's ventilating registers, black japanned, with cords, &c., complete.

Lay three courses of rough brick in mortar between the beams on top of sill.

Plastering: Cellar ceiling.—Lath and plaster the cellar ceiling one coat, smoothed.

Back plastering.—Back plaster the outside walls from sill to under side of plate, between the studs; the laths to be nailed to vertical strips or laths put on the inside of the boarding.

Two coat work.—Lath and plaster two coats in the best manner all other walls and ceilings except in woodshed, carrying the plaster to the floor everywhere. Laths to be seasoned pine or spruce, laid $\frac{3}{8}$ inch open, and breaking joint every six courses and over all door and window heads. The first coat of plaster to be of extra (*Rockland*) lime and clean, washed, sharp sand, and well mixed with long hair. The lime is to be slaked separately at least seven days before mixing with the sand and hair. The first coat to be well trowelled, straightened with a straight edge, and made perfectly true, and brought well up to the grounds. The skim coat is to be made with extra (*Rockland*) lime, slaked at least seven days before mixing, and washed (*beach*) sand, and well floated.

Point up with lime and hair mortar around window and door frames; patch up and repair all the plastering at the completion of the building, and leave all perfect.

Carpenter's specifications, &c.: Scantlings.—Sill 6 by 6 (*creosoted by Hayford Wood Preserving Company*), well painted on the under side. Plate, 4 by 4; corner posts, 4 by 6; window studs, 3 by 4; door studs, 4 by 4; all other studding, 2 by 4; 16 inches on centres. Braces, $1\frac{1}{2}$ by 4, gained in on the outside of the studding. There will be one 6 by 10

girder through the middle of the building, and the floor beams will be all 2 by 8 (2 by 9), (2 by 10), 16 inches on centres, notched down 4 inches on the sill and 1 inch on the girder. Rafters 2 by 8 (2 by 9), (2 by 10), 20 inches on centres, every pair of rafters to be tied at the foot with 1¼-inch plank at least 8 inches wide. (If space is gained overhead by putting the ties part way up the rafters these must be 2 by 10 or 2 by 12.) Hip and valley rafters 2 by 12 (3 by 12), (3 by 14). All rafters to be notched on the plate and spiked. Bridge the floor with two rows of double herringbone crossbridging.

Cornice.—Form cornice as shown on drawings, with gutter all around the building, and two (*four*) 3-inch patent expanding galvanized iron conductors where directed, with 2-inch lead goosenecks and quarter-turn at foot of each. Joints in gutters to be made tight with sheet lead.

Roofing.—Cover the roof with hemlock (*spruce*) (*pine*) boarding, planed one side to an even thickness, and two thicknesses of pine tarred (*Virginia rosin sized*) (*asphalted, Beaver brand*) felt paper.

Shingles.—Shingle with good sawed pine (*sawed or shaved cedar*) [sawed shingles rot sooner, but hold paint better] shingles laid 4½ inches to the weather and put on with two galvanized (*Swedes iron*) nails to each shingle.

Roofing with slate.—Cover the roof with matched pine boards, planed one side, two thicknesses pine tarred paper, and slate with best eastern (*Peachbottom*) (*Chapman's*) (*Vermont green*) (*red*) *slate not over* 8 *by* 16, *laid with 3 inches lap, and nailed with two galvanized* (*patent*) *nails to each slate.*

Flashings.—Cut channels in brick work of chimney and cement in wide flashings of 4-pound lead; shingle in (*slate in*) wide zinc flashings in valleys, and warrant all tight for one year. (*Cover ridge of slate roof with* 4-*pound lead, and slate in wide flashings on hips.*)

Outside finish.—Make finish and outside ornamental work, porch, &c., all of clear, seasoned pine, according to detail drawings.

Walls.—Inclose the walls with hemlock boards (*pine or spruce*) planed one side to an even thickness, and two thicknesses of good felt (*cane fibre*) paper, breaking joint, and cover with sap extra pine clapboards, 4½ inches to the weather (*edge sprung boards*) (*matched or rebated boards*) (*shingles*), all nailed with galvanized nails to every stud.

Casings, &c.—Casings and cornerboards 1¼ inches (⅞) thick. The top of all casings to be rebated and the under side of window sills ploughed to receive clapboards or shingles.

Porches.—Porches to stand on cedar (*locust*) (*creosoted spruce*) posts, 4 feet in the ground. Floors framed with 2 by 8 beams, and covered with matched ⅞-inch Georgia pine boards, well nailed and edge rounded. Fill in beneath with ⅞-inch boards jig-sawed as per detail drawing. Roof to have 2 by 4 rafters, with roofing as for main roofs, and ceiled underneath with ⅞-inch matched and beaded sheathing not over 4 inches wide, as shown on drawings.

Outside steps.—Make outside steps with $\frac{7}{8}$-inch pine risers and $1\frac{1}{4}$-inch Georgia pine treads, with rounded nosings returned at the ends, all supported on 2 by 12 inch strings, 12 inches on centres, the outer strings to be planed, and the foot of the strings to abut on a 4 by 4 piece, supported by two cedar (*locust*, &c.) posts, 4 feet in the ground. Make bulkhead to cellar with plank steps on plank strings, and cover of matched boards, battened, hung, and made tight.

Inside flooring.—Woodshed to have single floor of planed 2-inch plank. Other inside flooring to be double; under floor of planed hemlock (*second quality pine or spruce*) boards and upper floor of thoroughly seasoned and kiln dried first quality $\frac{7}{8}$ matched Georgia pine, not over 4 inches wide, laid in courses, breaking joint every course, thoroughly strained, and well blind nailed to every beam; all to be well smoothed and scrubbed at the completion of the building. Put felt paper between upper and under floor. (*Single floor of* $1\frac{1}{4}$ *matched Georgia pine.*)

Grounds and furring.—Put on grounds for $\frac{3}{4}$-inch plastering and beads on all angles. Cross fur the ceiling with 1 by 2 strips, 12 inches on centres.

Partitions.—Partitions to be set with 2 by 4 studs, 16 inches on centres, well straightened before plastering, and bridged once with angular plank bridging. Truss partitions where required.

Inside finish.—The inside finish to be all of first quality Indiana calico ash (*Michigan ash*, *Eastern brown ash*, *oak*, *cherry*, *black walnut*, *pine*, *whitewood*).

Wainscot.—Make panelled wainscot around main and class rooms and vestibules, as shown on drawings, in long horizontal panels, 2 feet high under blackboards, 4 feet high elsewhere. Framing to be bevelled. Put cap with trough as shown under blackboards.

Sheathing.—Sheathe dressing-rooms and lavatories 4 feet high with $\frac{7}{8}$-inch matched and beaded vertical ash sheathing, not over 4 inches wide, finished with neat bevelled cap.

Put on wainscot and sheathing before the upper floor is laid, and allow $\frac{1}{2}$ inch extra below floor.

Architraves.—All doors and windows to have $\frac{7}{8}$-inch by 4-inch plain board mitred architraves of ash, with bevelled edges.

Stool caps.—The capping of wainscot will run in to form stool cap of windows.

Doors.—Outside doors to be 6-panel as per detail drawings, $1\frac{3}{4}$ inches thick, of best seasoned clear pine, with bevelled framing, but no mouldings. All other doors to be $1\frac{1}{2}$ inches thick, 6-panelled, with flush mouldings, all of seasoned pine (*veneered with ash both sides*).

All doors to have rebated and beaded plank frames of ash, and hard wood (*Georgia pine or cherry*) thresholds (*saddles*), and all doors and finish to be of the best stock and kiln dried.

Windows.—Six cellar windows to have rebated plank frames and $1\frac{1}{2}$-inch pine sash hinged at top, with hook and staple to keep it open, and

iron button fastening. Make in addition two frames without sash for cold air box to furnace, and cover with strong wire netting.

All other windows to have boxed frames with pockets, hard pine or cherry beads and pulley styles, 2-inch sills pitching 1½ inches, 1¾-inch clear pine sashes in lights as shown, all double hung with good pulleys with cap over the top and galvanized face, best unbleached hemp cord and iron weights, accurately balanced. Inside beads of ash, put on with blued screws.

Wardrobes.—Fit up wardrobes with shelves, hooks on strips, shoe boxes, &c., as directed. Fit up washbowl in each, without cupboard beneath. Fit up water closets with whitewood (*tulip or bass wood*) seats to be hung with brass butts and screws and riser screwed on. Plough the sheathing into top of seat. Make earth boxes and apparatus complete as directed.

Miscellaneous.—Make cold air boxes as directed; cut holes for registers, and cut as required for plumbers and furnace men. Assist the other workmen. Make coal bins in woodshed. [Cold air boxes are best made of galvanized iron.]

Hardware.—All doors to be hung with 4 by 4 japanned acorn fast joint butts, put on with blued screws.

Outside doors to have brass face mortise lever locks; inside doors bronzed iron face, good common locks, all with plated or German silver keys (*Corbin or Nashua Lock Company's make*), and best lava knobs.

Water closet doors to have neat japanned barrel bolt in addition to lock.

Windows to have spring sash fasts, to cost $2 per dozen.

Hooks in wardrobes to be in two rows, 8 inches apart in each row, to be japanned cast iron, very stout. Heavy bulkhead doors with strong strap hinges, with staple and padlock fastening.

Painting: Outside.—Paint the roofs two coats best English Venetian red (*Rocky Mountain vermilion, Iron clad, Rossie*) paint in pure linseed oil (*slate paint, light or dark*). Paint all other outside woodwork two coats in tints as directed, touched with red as directed, using best pure lead and linseed oil. Paint sashes three coats, to finish bronze green (*white*). Oil two coats all hard wood floors and outside steps.

Inside.—Fill ash doors and interior wood work with wax and turpentine, or patent filler, and finish with two coats of shellac well rubbed down with emery cloth and oil. Puttystop after first coat; clean off all stains and leave all perfect.

Glazing.—Glaze in the best manner in lights as shown all outside sashes with first quality double thick American or German glass, back-puttied; clean off at the completion of the building, and leave all whole and perfect.

The carpenter is to clean up the building, scrub the floors, clear away rubbish, and leave the building clean.

MODEL CONTRACT.

Contract for building, made this —— day of ———, in the year ——, by and between the inhabitants of the town of Medford, in the county of Harrison and State of Texas, acting by their agent, William Smith, the chairman of the school committee of said town, the same being thereto lawfully authorized, party of the first part, and Thompson & Jones, of said Medford, builders, party of the second part.

The said party of the second part, for himself and each of his heirs, executors, administrators, and assigns, hereby covenants and agrees to and with the said party of the first part, his successors and legal representatives, for the consideration hereinafter mentioned, to make, erect, build, and finish a school-house for the said party of the first part on his land on Maple street in said Medford, including all the carpenter and mason work, excavation and grading, painting and glazing, but exclusive of furniture, and to furnish all the materials of every kind, labor, scaffolding, and cartage for the full completion of the said building, exclusive of its furniture, such work and materials to be in strict accordance with the drawings and specifications made by Henry Pratt, architect, which said drawings and specifications are to be taken and deemed as part of this contract,[1] and including all things which, in the opinion of the said architect, may fairly be inferred from such plans and specifications to be intended without being actually specified, all the materials to be in sufficient quantity, and where the quality is not described in the specification to be of the best quality, and the workmanship throughout to be of the best quality, and the whole to be executed in a good, substantial, and workmanlike manner, subject to the directions from time to time and to the satisfaction of the architect (*or superintendent*) and the whole to be completely finished and delivered on or before the fifth day of October next.

And the said party of the first part hereby promises and agrees in consideration of the foregoing covenants being strictly kept and performed by the said party of the second part, to pay to the said party of the second part the sum of two thousand five hundred dollars in two several payments as follows: One thousand dollars ($1,000) when the outside work is all done and painted one coat and the sashes in; and the balance thirty-three days[2] after the said building shall have been completely finished and delivered and accepted by the said party of the first part, unless some defect shall meanwhile have been discovered

[1] It is not necessary, though it is advisable, that the drawings and specifications should be signed; all that is requisite is that they may be easily identified.

[2] Any other number of days, but in any case postponing the final payment till a few days after the expiration of the time within which mechanics' liens can be entered against the building.

therein; provided that no payment shall be made except on the certificate of the architect or some other person thereto authorized by the said party of the first part that the work for which such payment is to be made is properly done and that the payment is due; said certificate, however, not exempting the party of the second part from liability to make good any work so certified if it be afterward discovered to have been improperly done or not according to the plans or specifications either in workmanship or materials; and provided, further, that prior to each payment by the party of the first part a satisfactory certificate shall have been obtained to the effect that the said building is, at the time when the payment is due, free from all mechanics' liens and other claims chargeable to the party of the second part.

And it is hereby further agreed, by and between the said parties hereto, that the drawings and specifications are intended to coöperate so that any works shown on the drawings and not mentioned in the specification or vice versa are to be executed by the party of the second part the same as if they were mentioned in the specification and shown on the drawings, without extra charge.

The said party of the first part or the said architect (*superintendent*), with the consent of the said party of the first part, shall be at liberty to order any variations from the drawings or specifications, either in adding thereto or diminishing therefrom or otherwise however; and such variations shall not vitiate this contract, but the difference shall be added to or deducted from the amount of the contract, as the case may be, by a fair and reasonable valuation, and the architect (*superintendent*) shall have power to extend the time of completion on account of alterations or additions so ordered, such extension to be certified by him to the party of the first part at the time when such order for alterations or additions is given. Orders for changes which do not affect the cost of the work may be given by word of mouth, but no order which increases or diminishes the cost of the work or affects the time of completion shall be valid unless given in writing.

Neither the whole nor any part of this contract shall be sublet by the party of the second part without the written consent of the party of the first part.

If the said party of the second part shall fail to complete the said works, including all variations, should such be made, at or before the time agreed upon, with such extension, if any, in the case of extra work as may have been made and certified by the architect (*superintendent*), then and in that case the said party of the second part shall forfeit and pay to the said party of the first part the sum of (*two to fifteen*) dollars for each and every day that the said works shall remain unfinished after that time, unless in the opinion of the architect (*superintendent*) such delay shall have been due to causes which could not have been reasonably foreseen by the party of the second part or with reasonable care

and diligence avoided, the same to be retained as liquidated damages out of any sums that may then be due or may thereafter become due to the said party of the second part on account of his work and materials under this contract.

All materials shall become the property of the party of the first part as soon as they are delivered on the ground.

If the said party of the second part shall become bankrupt or insolvent or assign his property for the benefit of creditors, or become otherwise unable himself to carry on the work, or shall at any time for six days neglect to do so in the manner required by the architect (*superintendent*), or refuse to follow his directions as to the mode of doing the work, or shall neglect or refuse to comply with any of the articles of this agreement, then the said party of the first part or his agent shall have the right and is hereby empowered to enter upon and take possession of the premises after giving two days' notice in writing, and thereupon all claim of the said party of the second part, his executors, administrators, and assigns shall cease, and the said party of the first part or his agent may, after using such other materials already on the ground as may be suitable, provide other materials and workmen sufficient to finish the said building, and the cost of such work and materials shall be deducted from the amount to be paid under this contract.

The party of the second part shall be solely responsible for all loss or damage to the said works or any part of them until the whole is delivered and accepted, loss by fire alone excepted; he shall keep his interest in the building at all times insured to an amount not less than fifteen hundred dollars ($1,500), and shall, if required, deposit the policy with the architect (*superintendent*) for approval and safe keeping, and shall give all necessary assistance to the other workmen employed in the building, and shall be solely responsible for all damage or delay caused to their work or materials or to neighboring property or to the persons or property of the public by his workmen or through his operations.[1]

And the said party of the first part agrees to keep his interest in the building insured against fire to an amount equal to that of the payments made on this contract until the building is delivered and accepted.

And for the faithful performance of each and every the articles and agreements hereinbefore contained the said parties hereto do hereby bind themselves, their heirs, executors, successors, administrators, and assigns, each to the other in the penal sum of one thousand dollars ($1,000) (*about one-third of the contract price*) firmly by these presents.

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[1] It saves trouble to have the party of the first part insure the whole risk, payable to him "for whom it concerns." The builder, however, may not be willing to trust him to divide the money in case of loss, and should not be compelled to do so; but as a fire while the builder's interest was uninsured would perhaps bankrupt him, causing expense and delay to both parties, he should be obliged to insure his interest himself if he is not disposed to trust the other party to do it for him.

In witness whereof the said parties hereto have hereunto set their hands and seals the day and year first above written.

THE TOWN OF MEDFORD, [SEAL.][1]

In presence of— By WILLIAM SMITH,
CHARLES HARRIS. *Chairman of the School Committee.*
EMILY THOMPSON. THOMPSON & JONES. [SEAL.][2]

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[1] The seal of the town must affixed.

[2] It is best, but not necessary, to have both partners sign. Each signature should be accompanied with a seal.

339-340

APPENDIX.[1]

The wigwam is superseded by houses built of logs before sawmills are erected in a new country. Combining, as it does, not a few excellences, this style of building deserves more consideration than it receives. There is no good reason why a well built log house should not be as comfortable as any other. Logs are non-conductors of heat. The sun does not "strike through them," as through a common hollow or any thin walled house. The timber can, in wooded regions, be had for the asking. The chopping, hauling, and construction involve more labor than the box-frame style of building, but the "money out" is less. Where labor and timber are plenty and money scarce, let there be more pains taken in erecting the building; then every advantage that is absolutely necessary may be gained. A good log house will last a generation.

The main building is 34 by 30 feet, with a lean-to of eight feet, subdivided into a teacher's room and anterooms; pitch of roof, 17 feet; projection of eaves, 3 feet; height of ceiling, 13 feet.

The construction of log houses is generally best understood by the frontiersmen who use them. The following hints may not be unacceptable to beginners:

Select timber which will last well when exposed to the weather. The logs should be 10 to 12 inches in diameter. The sills might be heavier, say 16 inches, squared, hollowed at the ends and pinned, or, better, spiked with 60-penny nails. The floor timbers are mortised with the sills and supported in centre by a bearing beam. The

[1] From School Houses and Cottages for the People of the South, by C. Thurston Chase.